MARCH, 1896.

THE ENGINEERING MAGAZINE

AN INDUSTRIAL REVIEW

EDITED BY JOHN R. DUNLAP.

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THE

ENGINEERING MAGAZINE

VOL. X. MARCH, 1896. No. 6.

THE MONEY QUESTION AND CONSTRUCTIVE ENTERPRISE.

By John R. Dunlap.

THE following letter from an appreciative subscriber in the West will explain itself:

To the Editor of THE ENGINEERING MAGAZINE,

I have enjoyed your publication as much as any other which has come to my table, and I subscribe for all the leading periodicals. But I am much disappointed at the appearance in your pages of the leading articles in your November, December, and January numbers, on the money question. I recognize the worth of the articles, but I subscribe for the leading financial papers, quarterlies, and reviews, in which I would expect to see such matter as this, and I cannot understand upon what grounds *you* give place to these articles by Messrs. Mills and White.

This is a criticism which I hope you will understand is made in a friendly spirit. I have a horror of the tendency which crops out in many publications with which we fall in love, of departing from the field in which we expect them to remain.

W. C. H.

Albuquerque, N. M., January, 1896.

This is a courteous and intelligent inquiry, and it is entitled to a full and frank answer.

In the official report of the United States Inter-State Commerce Commission dated June 30, 1894,—one year after the panic of 1893,—there occurs the following significant paragraph:

"On June 30, 1894, there were 156 railways in the hands of receivers. The mileage of road operated by these defaulting companies is 38,869.96 miles. Eighty per cent. of this mileage is accounted for by 28 important lines. Of the 128 remaining, 59 were small lines of less than 100 miles in length, some of them being parts of larger systems, and some being lines still in process of construction. The total capitalization of roads in the hands of receivers was about $2,500,000,000, or about one-fourth of the total capitalization of the country."

If our correspondent will picture in his mind's eye the tens of thousands of engineers who were thrown out of employment, deprived

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of prospective engagements, or suffered decrease in their incomes as the result of this prodigious aggregate of railroad insolvency; if he will form a mental estimate of the billions of capital employed in other lines of industry which were either wrecked or gravely imperiled by the same causes which produced this calamitous result in the railroad world; and then if he will endeavor to calculate the contingent losses which accrued to the millions of individual workers engaged throughout all lines of industry,—if he will do this, he can perhaps form some idea as to what a modern panic costs a great people. And in the nature of things, the causes which can produce such direful effects must be of the highest concern to the men who are engaged in constructive and industrial enterprise,—in a word, to the readers of this Magazine.

Now the panic of 1893 was purely and wholly a financial one. It was born of the most astonishing array of insane legislation upon finance and banking that has ever been witnessed in the history of any civilized people. That our readers may clearly comprehend the net results of this legislation, it is worth while to reproduce here an extract from a speech by Prof. J. Lawrence Loughlin, delivered in Chicago in October, 1894. The status of our public finance has never anywhere been more concisely presented, or more appropriately characterized. To illustrate the heterogeneous character of our currency, he presented the following official statement showing its component parts on October 1, 1894, which will apply substantially to the present date:

	Coined or Issued.	In treasury.	In circulation.
Gold coin	$579,728,587	$79,602,339	$500,126,248
Gold certificates	64,845,699	55,260	64,790,439
Silver dollars	421,176,408	366,900,165	54,276,243
Subsidiary silver	75,054,481	16,809,713	58,244,768
Silver certificates	339,676,504	9,155,785	330,520,719
Treasury notes (1890)	151,609,267	30,113,893	121,495,374
United States notes (greenbacks)	346,681,016	79,397,535	267,283,481
Currency certificates	56,305,000	550,000	55,755,000
National bank notes	207,564,458	5,017,748	202,546,710
Total	$2,242,641,420	$587,602,438	$1,655,038,982

Commenting upon this exhibit, he said: "We have here a dime museum of finance,—'the greatest aggregation of curiosities ever before exhibited under one canvas in the world.' There are nine different and confusing kinds of money,—two kinds of gold money, four kinds of silver money, and three kinds of paper money. The sum total of the four kinds of silver money amounts to about the same as the sum of the two kinds of gold money. Briefly, about 35 per cent. is gold, 35 per cent. is silver, and 30 per cent. is paper. . . . If anything should make us pause and deliberate on the ways of regu-

lating our monetary system, it would be that the loud-voiced, blatant demagogue is allowed to have unimpeded influence in regulating such an intricate mechanism as this."

This language seems almost like humor and ribaldry, but its every word is sober truth, and in no other form of expression can the situation be so fittingly described.

Back in the summer of '93, when agitation for the repeal of the Sherman Silver Bill was going on, there were thousands of intelligent men who believed that if we could stop the Government's monthly purchases of silver the trouble would be over. They saw that the silver advocates were both earnest and honest in the desire to maintain parity between gold and silver, thus insuring the discharge of all obligations upon the basis at which they were incurred; and they felt that if the Government would suspend the coinage of silver, all fear of its readiness and ability to maintain gold payments would disappear. But experience soon demonstrated that in reality the silver question constituted only one phase of the problem. Immediately after the repeal of the Sherman Bill the drain of gold from the Treasury set in afresh; one bond sale followed another in quick succession without checking the demand for redemption of the Government's fiat money; and thus has arisen the growing popular demand for the retirement of the greenbacks. It is obviously necessary that these notes shall be retired, and we can never hope for stability in our financial affairs until they are safely out of the way,—until the government "goes out of the banking business" and transfers to the banks the burden of carrying a gold reserve and supplying the gold that may be needed for export. But well-informed men see clearly enough that even this would not cure all our ills. The trouble lies yet deeper. Our banking system is not only imperfect and inadequate to the proper conduct of the business of our people, but it is crude, old-fashioned, and far behind the science of modern banking, as practised in every other civilized country. What we need, and what we must have before we can enter safely upon that era of splendid prosperity which surely awaits us, is, first, a simple, safe, and elastic system of national bank currency, which can be readily issued or retired by the banks in response to the varying demands of trade, and which will be adequate in volume to supply the place of the greenbacks and Treasury notes; and, second, such an amendment of the banking laws as will permit national banks, under proper restrictions, to establish branches in small towns and thinly settled districts throughout the country, to afford to our people the banking facilities which are necessary to the expeditious and profitable conduct of business.

Immediately the question arises, How is this reform to be accom-

plished? There is but one answer. It must come through the education of our people, and it can come in no other way. We live under a popular government, and as the people think, Congress will vote. Not until the country has declared itself in unmistakable terms can we hope for any adequate legislation in Washington; and, meanwhile, we must rely upon demonstrating to all the world the great wealth, the splendid resources, and the loyal patriotism of our people,—which have happily been so conspicuously proved in the recent public sale of government bonds.

Reasoning thus, it has seemed obvious to me that the surest and speediest method for accomplishing the end desired, must be through *the education of the leaders* of the people,—the proprietors, heads of concerns, chiefs of departments, superintendents, managers, and active men of affairs generally, who employ large numbers of men and who hold the confidence of the voters. It is precisely this constituency which THE ENGINEERING MAGAZINE strives to serve, and I have, therefore, accounted it a matter of the highest importance that the financial problem should be treated in these pages from the point of view of the engineer and the practical man, rather than from the stand-point of the financier or the politician, as is usual in the financial and political reviews. Every resource has been exhausted in the effort to obtain the best thought of the foremost minds in the world; each and every phase of the problem has been clearly expounded by an expert; each subject has been treated in its relation to those which have gone before; and, as a whole, the series of papers would make a valuable text-book. That this may be appreciated, I present here a list of the titles and authors, with the date of each publication:

Aug. '93.	THE UNIT OF VALUE IN ALL TRADE— As Fixed by Commerce Regardless of Legislation.	EDWARD ATKINSON.
Sept. '93.	A SCIENTIFIC ANALYSIS OF MONEY— A Standard of Value Mathematically Defined.	EMIL SCHALK.
Oct. '93.	THE REAL CURRENCY OF COMMERCE— Checks, Drafts, Notes and Bills of Exchange.	GEORGE S. COE.
Dec. '94.	THE "BALTIMORE PLAN" OF CURRENCY REFORM— Approved by the Bankers' Association of the U. S.	A. P. HEPBURN.
Jan. '95.	SILVER COINAGE HISTORICALLY CONSIDERED— A Masterly Review of Facts and Principles.	H. D. MCLEOD.
Nov. '95.	THE CURRENCY PROBLEM AND ITS SOLUTION— A Business Man's Idea of the Situation.	ABRAHAM MILLS.
Dec. '95.	FIRST PRINCIPLES IN MONEY AND BANKING— The Currency Problem in American History.	HORACE WHITE.
Jan. '96.	REPRESENTATIVE MONEY AND GOLD EXPORTATION— An Excess of One Leads Inevitably to the Other.	HORACE WHITE.

As a timely and fitting addition to this series, it affords me pleasure to commend in the highest terms the very excellent article on "The Scotch System of Branch Banks," by Mr. J. Selwin Tait, which follows. This may, indeed, be fairly accounted the most important paper in the series, for the essential reason that it lays bare the tap-root of the whole difficulty. In addition to showing the great superiority of the Scotch and English system of banking over our own, Mr. Tait proves that by simply amending our national bank laws to conform with the modern system which has made London pre eminent in the financial world, we can add the magnificent aggregate of $750,000,000 to the capital which is available for productive enterprise,—and this too of capital which is now needlessly employed in banking or lying idle and useless in our bank reserves. Here is a possible addition to our "circulating medium" which must satisfy the demands of even the wildest inflationists,—for as Mr. George S. Coe, the distinguished inventor of the clearing house certificate, has clearly shown in these pages, (October, 1893) "the real currency of commerce" is made up of bank credits, with the checks, notes, drafts, and bills of exchange which are based upon them. If this fact can ever be driven home to the addled pates of our ten thousand philosophers of inflation, the money question will settle itself in short order. Afford safe and adequate banking facilities to the farmer, the village manufacturer, the artisan, and the small tradesman; give him a credit in bank and a check book to make that bank credit available, and he will soon learn that actual money plays a very small part in the transaction of business,—he will, in fact, learn what the clearing-houses have taught the people of our large cities long ago, namely, that of all the stupendous aggregates of modern business transactions, less than $1 in every $20 is represented by the actual use of money.

And just here it seems proper to repeat what I said in these pages in December, 1894. "It requires no prophet to foresee that the question which must dominate all others in public interest during the coming twelve months, is that of reforming the polyglot system of currency and banking under which the commerce and industry of the United States are now struggling. . . . Back of the Populist demand for 'more money' and 'cheap money'; back of the sentiment favorable to silver coinage upon some safe basis; and back of the unrest and discontent which are manifest in all parties, there is the definite knowledge that our present currency system is both complicated and defective,—that at certain seasons it is inadequate to commercial requirements, and in times of panic positively dangerous to the welfare of our people. This is the vital defect which gives plausibility to all the financial vagaries now prevalent; and whatever sins

may be charged against the silver inflationists and the fiat money cranks, they must be credited with having finally aroused the conservatism of the country to a clear appreciation of the fact that financial reform is an imperative need."

"It may be said that the movement for reform was inaugurated with the panic of 1893. The wholesale issue of clearing-house certificates, the widespread use of certified checks in place of money, and the premium, not on gold alone, but on currency as well,—these were object lessons in finance which brought home to every man the obvious truth that our currency system was defective, and that it lacked the essential quality of being readily expanded or contracted to meet perfectly legimate requirements."

What was true at that time is true to-day.

In both houses of Congress, and notably in the Senate, there are blatant demagogues who wantonly proclaim doctrines which they know to be false; but in the Senate, as well as in the House, the overwhelming majority of the congressmen who stand for silver coinage or uphold the greenback, are sincerely convinced that they are right. They see that something is radically wrong, and they are simply following their best lights in the effort to solve the problem. More than this, they know that in thus upholding honest convictions they represent the sentiments of their people. In truth, the only kind of money that the present generation has learned anything about is government money and silver money, with an occasional glimpse of gold. It is logically necessary, therefore, that they should believe in the money which for thirty years they have been using; and though they are in error as to the true principles of finance, they are manifestly honest in the theories which they uphold. Nor does this condition of public opinion apply merely to a minority. The candid man must admit that the majority of our people believe that the government should issue our money, and many believe that the silver men have an element of honest truth in their platform. But with that conservatism which is the bulwark of free institutions,—which makes it always safe to trust the people,—a square halt has been called. The voters will not permit any additional coinage of silver, and already they are in the attitude of waiting for further information concerning greenbacks and government money generally. This is undoubtedly true of the people, and it is notably true of their honest leaders. In all the pages of political history a more heroic example of loyalty to plain duty and honest conviction has not been written, than in the frank declaration of Senator Mills, of Texas, that he regards it as impossible for this country alone to establish the free coinage of silver.

To the thoughtful man it must be apparent, then, that the para-

mount duty of this hour is to teach sound principles of finance,—to spread the light to the people who are waiting for it. This is a duty which rests, not upon our representatives in Congress, or some special set of men who comprehend the whole science of finance, but it rests equally upon all men of intelligence and influence. It should find expression in private conversation, in business correspondence, through the columns of the newspaper press, in the pages of the magazines and reviews, especially through the medium of commercial exchanges, boards of trade, and chambers of commerce,—and more important than all else, the demand for a sound currency and a civilized system of banking should be made so manifest at every political convention between now and next fall, that when the voters come to the polls for the presidential election in November next, there shall be absolutely no mistake as to the demand of the people of the United States for the best money and the best banking system that the world affords.

And now I want to go beyond the ordinary bounds of a magazine article for the purpose of saying, that the most valuable, the most comprehensive, the most complete, and the most convincing contribution that has yet been made to the literature of the money question as it exists in the United States to day, is the incomparable little volume by Mr. Horace White, entitled "Money and Banking," which has recently been published by Ginn & Co., Boston. In the issues of this Magazine for December and January last I attempted, in two articles made up of selected quotations, to convey some adequate idea of the value of this work. But to the man who wishes to thoroughly understand the situation which confronts us, and to be in a position to exercise an influence over the people of his community, these few extracts are wholly inadequate to the purpose. The book itself should be procured, and once in hand its reading will be found as pleasurable and inspiring as it is undoubtedly instructive. From cover to cover it deals in essential facts, rather than theories; and using the familiar events of our whole financial history to illustrate the obvious principles of sound finance, it makes the whole subject so clear that no reasonable man can possibly go astray.

In this little book, in exposing the fundamental fallacy of money issued by a government, Mr. White declares that "the greatest objection of all to fiat money is that it teaches people to believe lies. It creates the belief that the government can make money—that is, real, not representative, money—than which a more damaging lie never gained lodgment in the human brain." This is true, but it is an incomplete statement. A still more damaging influence which must be charged against fiat money, is that it teaches people to believe that the banks should not be permitted to issue representative, or paper, money.

The belief is wide spread throughout the United States that the privilege of issuing money is a very valuable one; that the banks are anxious to secure and control it for their private profit; and that the Government should protect the people against the "soulless money changers" who design to charge a profit for the use of what should be "the people's money." Of all the stupid fallacies that have ever gained currency surely this is the most senseless and the most damaging.

As a rule a bank's capital and surplus are about represented by the cash reserve which is necessary to a safe business. Hence it follows that banking income and banking profits are derived almost wholly from deposits, which are loaned out at interest. In proof of this I need only cite the fact that the aggregate deposits, of our national, state, and savings banks at present average about $4,250,000,000, while the national bank notes now in circulation amount to less than $200,000,000. If the greenbacks ($346,600,000) and the Treasury notes ($152,600,000) were immediately converted into national bank currency, the aggregate of bank circulation would still be less than $700,000,000,—or practically one-sixth part of the vast sums of money which the people gladly commit to the care of the bankers, to be used for their individual profit, in return for the security, the accommodation, and the convenience which the banks afford.

This is so simple and so obvious a demonstration of the source of banking profits that one marvels at the widespread popular notion that bankers are eager for the privilege of issuing money, and that such a privilege should be denied them. The truth is that for years past our national bank circulation has been declining in volume because it is unprofitable to the banks; and under any possible or approved system, the necessary outlay of capital to provide security for the notes, and the cost of supervision and insurance against loss, must make the net profit on bank circulation a very slender one at best. But the issue of money is a natural and indispensable feature of a sound banking system, for the essential reason that the people make known their money requirements through the banks. The banker is, therefore, the only man in a position to decide promptly and intelligently as to whether or not money is required for legitimate business transactions; his self-interest will induce him to supply it when needed by responsible borrowers; the cost of issuing it will force him to retire it when no longer needed; and not until we secure this automatic adjustment of currency issues through the banks, can we hope for that even course of business which is so indispensable to peace and prosperity. As Mr. Horace White has so aptly said: "The redemption of fiat money is always liable to contingencies. The government may not be *able* at all times to redeem it. The government may not be *willing* at all times to re-

deem it, in which case it cannot be coerced, or fined, as a bank may be for similar default. The national honor is a very poor substitute for the sheriff and his posse, to keep specie payments going."

To the student of the subject who has no selfish interest to serve and no pet theory to uphold, the way is so plain that he cannot go wrong; and to the man who knows the American people and has learned their sterling honesty, their love of country, and their ardor for the right, there can be no fear of the final issue. Time and teaching are the needful things, and the leason to be learned is so simple that it can be written in a few sentences:

Retire the government's fiat money, which acts as "an endless chain" in depleting the Treasury gold reserve; make it possible for the banks to issue currency at a slight profit above the known cost; require each of the banks, instead of the government, to redeem its own notes in gold on demand; and finally, give national banks the right to establish branches wherever they may be needed. Do these things, and the people will have made a bargain with their bankers the benefits of which will be simply incalculable!

THE SCOTCH SYSTEM OF BRANCH BANKS.

By J. Selwin Tait.

IN a recent letter to the press I used an argument in favor of branch banks which I may be permitted to repeat. "To the uninitiated it may seem a matter of small moment whether the country's banking is done by several thousand separate institutions—national and State—or by a small number of banks with a large number of branches, provided that both systems are equally safe; and yet the independent bank of one roof and the many roofed or branch bank are so widely different in their results that the change from one to the other would mean the releasing of hundreds of millions of dollars of cash reserves, and might be made to mean the changing of our New York money market from a European plaything, knocked hither and thither at London's behest, to a great financial potentiality, which in its turn could make a bold bid for the financial supremacy of the world.

"In wealth the United States is not exceeded by any European country; but its money lacks the power of concentration as well as the mobility which gives London the monetary control of the globe. If one could imagine Niagara's flood scattered all over the country in innumerable lakes and ponds, and left to find its way to the ocean through ten thousand little rivulets, instead of uniting its waters to form a force sufficient to turn every wheel on this continent, that would form a scarcely exaggerated example of the difference between capital divided among thousands of independent banks and capital united and mobilized under the branch system."

Under the national bank law the large concerns in New York and other reserve cities are required to keep twenty-five per cent of their capital as a cash reserve. Similar establishments in London, which act for country banks in much the same capacity, keep about ten per cent. less cash reserve than our national bank laws require. In this country we have 3,712 national banks with deposits of $1,715,000,000. These banks are compelled by law to keep from fifteen to twenty-five per cent. of their deposits in cash, so that the less elastic system keeps needlessly in idleness a considerable portion of the country's capital.

If the country banks which withdraw from the leading cities the many millions of dollars necessary to handle the crops each fall were simply branches of large institutions having their chief offices in central cities, a smaller proportion of cash reserve would be necessary than is made obligatory, and thus millions now lying idle would be available for agricultural, commercial, and industrial enterprise. Funds

accumulated during the winter and spring and summer by the central offices of these banks and shipped to outlying branches in the fall to be divided among hundreds of thousands of people interested in agriculture directly or indirectly might be compared to a rainfall which fills the streams, then the rivers, and eventually reaches the sea, whence by natural action it again becomes transformed into rain.

A forcible illustration will be found in a comparison of the average amount of capital and surplus of each national bank with that of each English branch bank. The 3,712 national banks of this country have an aggregate capital and surplus of $903,000,000, or an average of $240,571 per bank. Taking the ten joint stock banks of London which have the largest number of country branches, it will be found that they have a combined capital and surplus amounting to $99,366,250. This total divided by their number of branches (1,343) gives $74,000 of capital and surplus to each branch. From this comparison it is clear that, were the same amount of working capital and surplus employed under the branch system, it would be sufficient for 12,127 banking establishments instead of 3,712. It is, therefore, apparent that we have sufficient banking capital already in use *to increase the number of our banking establishments three hundred per cent.*, if employed under a proper system; or, to put it in another way, in consequence of the cumbrous and antiquated character of our banking methods, we have in our national banking institutions more money than is necessary by $628,312,000.

As this comparison of the respective amounts of capital and surplus employed by the English banks and our own national banks is a very important one, I think it only right to give a list of the English banks embraced in my figures. Any one familiar with the subject and examining this list will admit that it includes only those banks which best represent the idea of a central office in London with branches scattered over the country.

Name of Bank.	No. of Branches.	Capital. £	Reserve fund or Surplus. £
Capital & Counties Bank	184	930,000	722,000
Lloyds	195	1,780,000	1,000,000
National Provincial	172	3,000,000	2,000,000
Williams, Deacon	64	1,000,000	440,000
National	105	1,500,000	290,000
London & County	177	2,000,000	1,000,000
London & Midland	142	983,000	700,000
London & So. Western	101	600,000	250,000
London & Provincial	137	500,000	605,000
Parr's	66	500,000	71,250
	1,343	£12,795,000 or $63,975,000	£7,078,250 or $35,391,250

A comparison with the State banks is much less striking, as these average only $88,419 in capital and surplus; but, compared with the branch banks, even these lock up in the aggregate $53,483,892 more than is necessary. Adding together the capital and surplus needlessly locked up by the national and State banks, and the excessive reserves which the system of isolated banks renders imperative, we have the astonishing spectacle of a country which needs every dollar of its capital locking up $750,000,000 more than is necessary in one form of business alone. Such a condition of affairs is a reflection upon the intelligence of our people.

The national banks of this country number 3,712, and the State banks 3,586. Here, then, is the spectacle of 7,298 independent banks, without cohesion or combination, but each determined, on the first appearance of danger, to save itself at whatever cost to the others or to the community at large. Although we have the object lesson of the New York Clearing-House banks uniting in mutual support during troublous times, there is virtually no standing shoulder to shoulder in this vast army to resist an onslaught; and there cannot be, because, after all, each bank is a purely local and isolated institution, equally so in its sentiments as in its depositors and stockholders. And this consideration brings to light another danger.

By far the larger part of the capital of our national banks is held in the vicinity where the bank is located, so that a local depression which endangers the bank threatens a double blow,—first to the depositor, and then to the stockholder,—and so precipitates the danger of a panic. In order to illustrate how immensely superior the branch bank system is for country places subject to depression and consequent danger, I would say that I could name banks of the kind, in London and in Edinburgh, which *could each lose the total assets of a dozen of their country branches and never pass a dividend.* Will any one say that the existence of a branch of such a bank in a town would not be a tower of strength and a restorer of confidence in times of peril?

Of course it is not to be supposed that any banking scheme would be entitled to a moment's consideration which would endanger the safety of national or State banks with deposits amounting to $2,373,000,000. The branch system, if introduced to-morrow, would begin its work very gradually, and would take its place in the banking economy of the country without any disturbance or dislocation of existing conditions. Wherever the branch of a strong bank was placed, it would be at once a source of confidence as an earnest of outside help when needed. In this way the system might make considerable progress in times of depression, but at first its progress would be slow.

Joint stock banks with branches were started in England upwards

of sixty years ago, although Scotland had them long prior to that period. When these branches first made their appearance, England was covered with private banks of influence and wealth. These banks, for the most part, had been in existence a great number of years, their owners were usually the most respected members of the community, and, as a whole, the people—the most conservative in the world—believed in them like a creed. It seemed almost hopeless to expect that country people, with whom "confidence is a plant of extremely slow growth," would deposit their money with institutions which must have seemed to them new-fangled, and which were without any of the local influence and character of the home bank; yet what is the result? After the lapse of half a century the branch banks of England have absolutely swallowed up the whole private banking system, one bank alone having absorbed between three and four hundred. The success of the branch bank is simply the survival of the fittest.

London is to-day the center of domestic, colonial, and foreign banks with branches whose deposits are considerably in excess of $5,000,000,000, and this enormous growth is, with the exception of Scotland's share in it, very largely the outcome of the branch bank system during the last fifty or sixty years. Not only has London's monetary position been greatly strengthened by the change in England's banking system, but every city and village in the country has benefited by her gain. In fact, the whole country, but especially the English metropolis, has gained weight and prestige through the change in the banking system, which has meant the mobilization of practically every coin in the country, and—what is far more important—an increased stability in her credit. The knowledge that all the money of the country is within instant reach and can be sent promptly hither and thither as occasion may demand, is a source of continual confidence, and that confidence has made the gold sovereign of England to-day the basis of the most stupendous pyramid of credit the world has ever seen. The enviable position which Great Britain holds as the money center of the world is the logical outcome of her improved banking system.

Simultaneously with the development of her banking along the most intelligent lines, England gave much attention to the framing of the Companies' Acts regulating the formation of investment incorporations, and safe-guarding as far as possible the investor, so that the influences which attract capital and confidence to London should not be made the means of injuring her vast army of small capitalists. The result is that to-day London is practically the investing center of the entire British Islands, and there is not a single stockholder in the United Kingdom whose name and address is not on file in the brokers' offices in London. In this way the English metropolis is not only the recep-

tacle of enormous accumulations of capital, but the distributing point as well, and this is why London's voice is so potential on our own exchanges to-day. She speaks for all England. In the way they have handled their opportunities Great Britain and this country afford respectively an interesting study of how to attract capital and investors and how not to do so.

As regards the safety of branch banks, it may be said that a failure among English joint stock banks with branches is so rare that such a catastrophe may almost be said to be unknown.

In point of profitableness it may be pointed out that the capital stock of the banks named stands at an average premium of over 250 per cent., and, although a considerable liability attaches to their shares, they are in such good repute and the market for them in the financial centers is so assured that they yield less than 4½ per cent. at the market price. Before passing from this question of profitableness, it may not be amiss to refer to the enormous advantage which a stockholder in a large bank with its chief office in the money center of the country—thereby having a wide market for his stock—has over the holder of shares in a local bank limited to a local market and subject, not only to local vicissitudes, but also to lack of funds to buy.

In the case of the ten banks named, the stockholders number 51,629. These are scattered over the entire country, so that whatever risk there is is widely scattered and in no sense local.

The expenses, all told, of conducting such establishments are less than one and a half per cent. per annum of the amount due their depositors. In the case of very large banks with few branches the expenses are still less; thus, in the case of the London and Westminster Bank, with only seventeen branches, all of which are in London, and deposits amounting to $130,759,670, the annual expenses are less than one per cent. of the total amount due depositors.

A bank with branches has an immense advantage over its isolated rivals, in that it offers to its customers exceptional facilities for conducting business with cities where it has branches; and, in the case of a moving population, it gains depositors at every turn, since a new arrival in a city naturally gravitates to the branch of the bank he has known in his own town, even if he did not do business with it there.

The many-roofed bank meets the business man wherever he goes, and its very ubiquity engenders a confidence which helps credit very largely. Take the case of a new town where no bank has previously existed, and where there is not a cent of unused capital with which to start one. Let a bank, long and honorably known in a hundred cities, open a branch there without taxing the inhabitants for a dollar of capital, but, on the contrary, with the offer of such financial assist-

ance as their business justified, and the establishment of such a branch, which in the worst times of danger would be felt to be as strong as its powerful parent establishment, would be a great stimulus to confidence and a source of an immensely-increased business. Multiply such a branch bank a thousand-fold throughout the newer sections of the country, and it is difficult to estimate the good which would result to business.

When the branch idea, or "agency," was in its infancy in Scotland, that country was the poorest on the face of the globe. For a great many years the entire country has been covered with branch banks or agencies, and to day Scotland boasts ten banks with a thousand branches and justly claims that, *per capita*, she is the wealthiest country in the world, although her climate is as bleak and her soil as niggardly as when she was the poorest. Scotland owes no small part of the change to her banking system, if indeed she does not owe it all. In the hands of a thrifty, honest people her banking cash-credit system worked out through the banks' agencies was a Godsend to the country at large, and was the finest exemplification ever seen of the power of credit in developing commerce and inducing wealth.

The actual expenses of conducting branch banks are relatively small compared with those of independent banks. There is neither president or board of directors for the local establishment to provide for, the business being conducted by a manager and staff. The manager of a branch bank is supreme under his own roof, and would not be out-ranked by any president of a competing bank. In England it was originally the custom to choose bank managers from the most influential men of the town, but the practice was abandoned long years ago, and now they are selected from among the bank's ablest officers. They are invariably men of culture and address, and of good business training. They are much more likely, from their experience in large cities, to be able to answer the business questions which country bank customers ask of bank presidents and cashiers than the president whose knowledge is more local. The branch bank system is a death-blow to nepotism in making up the office staff. Each officer of the new branch is a well-trained official from the chief office, and, if he has no local sympathies or affinities, he has at the same time no antipathies. The discipline is military in its strictness, and, as stated, there is no kinship among the officers to induce looseness in supervision or undue leniency towards irregularities.

Boys who enter such a bank are understood to have decided upon banking as a career, and, as a rule, they follow that profession until they are comfortably pensioned off. There is no doubt that the pension as an institution is the very soundest policy. It makes the official content to work for a moderate salary, since his future is provided for

and the fear of endangering it doubles his carefulness. Men inured to the handling of money from their earliest youth, and taught above everything the sacredness of banking money, are little apt to tamper with the bank cash in after life. Still, no risks are taken, and in the branches themselves and on the part of the head office the most rigid system of inspection conceivable is carried on, with the result that the great branch banks of England with chief offices in London—and these I consider to be the most perfectly managed banking institutions in the world—have suffered no appreciable loss from the defalcation of an employee for upwards of thirty years,—a wonderful record, it will be admitted, when the experience of our own banks is taken into account.

In the advantage to be derived from a simple and uniform system of bookkeeping in all the branches, in the bank's ability to locate its branches so that a superfluity of deposits at one center will be offset by the special demands of another locality, and in a variety of ways too numerous to refer to in a short article, the branch bank has an advantage over its rivals.

If it be feared that the branch bank system would cause a dangerous concentration of capital and monetary power in the large cities, it may be replied that the same kind of argument could have been used for forbidding the building of trunk lines, on the ground that, by furnishing undue facilities for travel, they were calculated to remove our country residents into our cities, and so concentrate population there. Instead of this, railway trunk lines have been the only possible agents for the adequate opening-up of the country. And so it is with the branch banking system. It mobilizes the country's capital, and maintains that regular ebb and flow of money between the large cities and country towns which the exigencies of both demand. Indeed, it is apparent at this late hour of the nineteenth century that, instead of such establishments having an undue weight in the large cities, an influence of the kind might be advantageous to balance the over-preponderance of capital, and the power it represents, now in the hands of certain private bankers. We have recently witnessed a spectacle of the kind, in which it seemed for a time that a single private banker of the city of New York could practically dominate all the banks of the country and virtually control all the available gold,—a most undesirable condition of affairs, which does not exist in any other great country.

Space forbids me to say more, but I think that any dispassionate reader, after studying the claims of the branch bank system here advanced, will agree that, when President Cleveland recommended the formation of branch banks in his last message, he did an eminently wise thing.

PROFESSOR RÖNTGEN'S DISCOVERY OF A NEW RADIANCE.

By Michael I. Pupin.

RÖNTGEN'S discovery of what appears to be a new form of radiant energy has justly atracted universal attention. The interest attached to it is a twofold one: first, its purely scientific significance; second, its practical importance. The discovery may be stated broadly as follows: if an electric current be sent through a vacuum tube—the so-called Crookes tube,—then, in addition to the heat and fluorescent light generated in the glass of the tube, there is, according to Röntgen's discovery, another form of radiant energy generated, which we may call the Röntgen rays. The following characteristic elements describe this energy: it produces fluorescence in fluorescent substances, just as ultra-violet light; it affects the photographic plate, just as the actinic part of the solar spectrum; it penetrates all bodies, even the metals, in a greater or smaller degree, and it is neither reflected or refracted appreciably. No other known form of radiant energy resembles the Röntgen rays in this last respect.

Much has been written lately about this discovery, but little has been said which would serve as trusty and intelligible guidance to those who are not familiar with modern electric appliances. It seems desirable, therefore, to give here a brief and simple description of the apparatus, and of the method of operation.

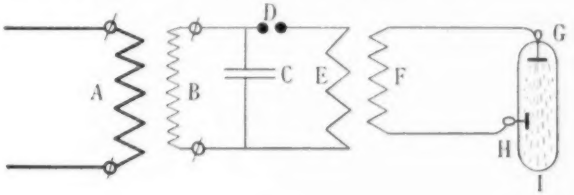


Fig. 1.

In Fig. 1 we have an ordinary induction coil, AB. Its primary coil, A, is connected to the mains of an alternating current circuit, and the supply of current is regulated by an auxiliary resistance-box. The secondary winding, B, is connected to a Leyden jar, C. A gal-

lon jar with a medium-sized coil gives a sufficiently strong effect. The jar is connected to an oscillatory transformer, EF, which needs a more detailed description. It can be constructed as follows. Take two large glass jars, A and B (Fig. 2); wind about eighteen turns of very coarse, well-insulated wire, aa, on the outside jar, B, and about two hundred turns of fine wire, bb, on the inside jar. Place the jar, A, into B, and fill the space between them with very hot paraffin. Pour very hot beeswax over the outside winding, aa, until a thick crust is formed. This is then an oscillatory transformer. The coarse wire winding, aa, is the primary, and the fine wire winding is the secondary, of this transformer. In Fig. 1 the primary, indicated by E, is connected to the Leyden jar, C, and the secondary to the vacuum tube, GH. The plateholder, L, containing the sensitive photographic plate, mm, is in line with the electrode, G, so that it is in the line of discharge from this electrode. The object, K, to be photographed, is placed between the tube and the plate.

Fig.2.

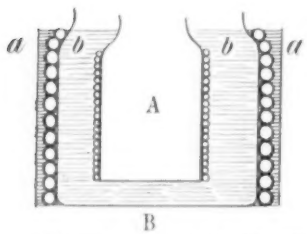
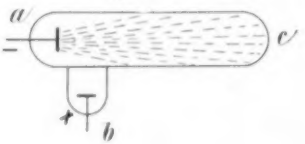


Fig.3.



We can pass now to the operation. Observe first that the circuit, CDE, contains an air-gap, D, between two small brass spheres. As soon as the current is admitted into A, there is induced a very high tension current in B, which charges the jar until the tension between the small spheres of the air-gap is high enough to break through. The jar discharges then, and the discharge current will oscillate back and forth in the circuit, CDE, at a rate of several hundred thousand vibrations per second. These vibrations die out rapidly, but the alternating current in B makes a break through the gap, D, at every alternation, and sets up, after each disruptive break, a series of oscillations. In fact, the circuit, CDE, may be compared to a church bell, and the disruptive action at the gap, D, performs the function of the swinging tongue of the bell. After each stroke, a series of waves spreads out into space,—melodious sound waves in one case, silent electric waves in the other. These rapidly-vibrating waves induce in the secondary circuit, F, a series of waves of the same rapidity, but of much

HAND TAKEN BY M. I. PUPIN.

Employing a Holtz Machine and a Crookes Tube. Time of Exposure, 50 Minutes.

higher tension. The oscillatory current in the tube, GH, produces a luminescence in the attenuated gas in the vacuum tube. If the vacuum is not very high, the luminescence is almost entirely within the gas itself; this is not the case in very high vacua. For the purpose of pointing out clearly how these Röntgen rays are produced, it is well

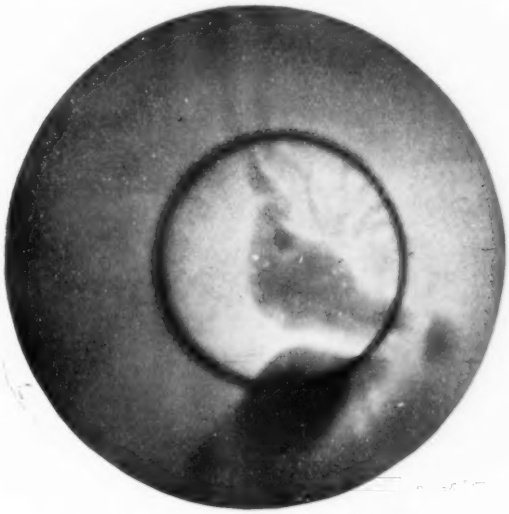
to consider briefly the electrical discharge in the tube when the vacuum is very high.

Fig. 3. represents a typical form of a vacuum tube, capable of giving a strong Röntgen effect. Two platinum wires, a and b, carrying aluminum discs, are sealed in a glass tube. They are the electrodes which are connected to the high tension coil. The electrode which at any moment is connected to the negative pole is called the cathode, and that connected to the positive pole is the anode. When the current is oscillatory, as in the arrangement described in Fig. 1, each electrode alternates periodically between being anode and cathode. Thus, in an alternating current reversing one hundred times per second, each electrode will be anode fifty times and cathode fifty times per second. Fix, now, any moment when a is the cathode and b is the anode. Suppose that the air pressure in the tube has been gradually reduced by the action of a mercury pump to something like one millionth of an atmosphere. The electrical discharge, which, as long as the vacuum is not high, appears as a bright luminescence of the gas, is hardly visible at this excessively low pressure.

In place of this luminescence of the gas, there appears in very high vacua a vivid fluorescence of the glass,—blue in American glass, green in German glass. This fluorescence is produced by faint streamers which proceed in straight lines from the cathode, as indicated by the dotted lines in Fig. 3. Where these streamers meet the tube, there the fluorescence and the heating of the glass take place. Professor Röntgen finds that this brightly-fluorescing surface in the walls of the tube is the seat of a radiant energy, which possesses the characteristic features described above. These rays, which Röntgen calls the X-rays, can be observed in a dark room by means of a paper screen saturated with an emulsion of a fluorescing substance. The discoverer employed barium platino-cyanid. Wherever the rays strike this screen, they cause it to fluoresce, and the intensity of the fluorescence measures the intensity of the Röntgen rays. By interposing a substance between the tube and the screen, the relative opacity of the substance for these rays can be determined. It is found that even metals are transparent to it, but in various degrees. Thus, if a given thickness of platinum will absorb a certain amount of these rays, it is found that the same amount of absorption will be produced by a lead plate of three times the thickness, by a zinc plate of six times the thickness, and by an aluminum plate of two hundred times the thickness. Wood, ebonite, rubber, water, and organic compounds, are more transparent than metals, but none of them are perfectly transparent, nor is any substance perfectly opaque. A fact deserving an especial mention is that glass, especially that containing lead, is nearly opaque. Bone is much more

opaque than flesh ; the shadow of a human hand on a fluorescent screen will, therefore, show the skeleton darker than the flesh.

Another method of studying this new form of radiant energy is by means of photography. Röntgen found that a photographic film is affected by the X-rays, but, since these rays are neither reflected or refracted, it is useless to employ lenses. The plate remains shut up in the plate-holder, and the object to be photographed is placed upon it, so as to be between the tube and the plate, as indicated in Fig. 1. The time of exposure varies with the quality of the vacuum and the

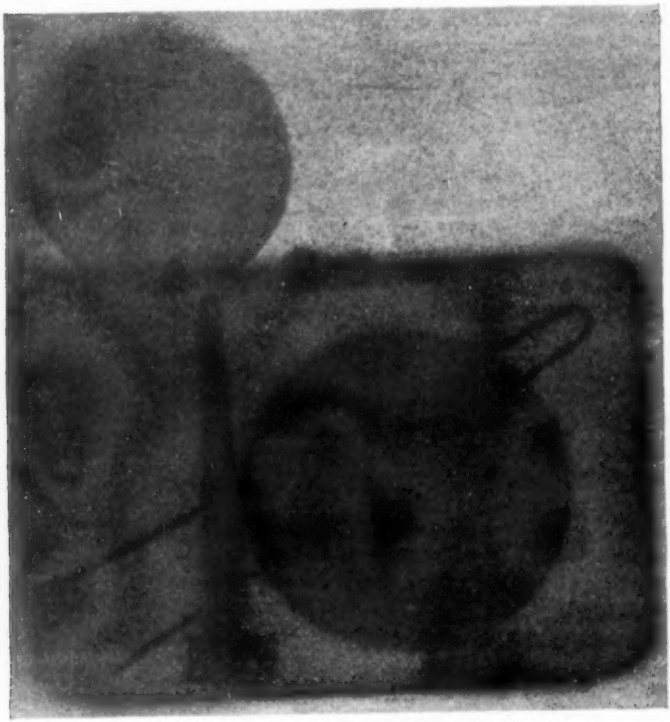


AN ALUMINUM DISC WITH FIGURES IN RELIEF.

The negative shows much detail and also want of homogeneity in the metal of the upper plate above the crest of of the bird, the plate being less transparent in this part than in the lower part. Taken by M. I. Pupin with a Holtz machine and an electrodeless tube. Time of exposure, 25 minutes.

electric tension employed. It may be as short as four minutes, or it may be as long as two hours. The nearer the tube is to the plate, the shorter is the time of exposure, but evidently the less defined will be the shadow picture. There is good prospect of perfecting both the means of producing the vacua and also the construction of the tubes, so as to produce the X-rays in a larger quantity. This would shorten the time of exposure, and also improve the definition of the photographs.

Röntgen's experiments have been repeated in this country in several laboratories,—at Harvard, Yale, Johns Hopkins, Princeton, and



ALUMINUM BOX CONTAINING AN ALUMINUM MEDAL AND HAIRPIN.
Under-exposed. Taken by M. I. Pupin.

in the writer's laboratory at Columbia. At the McGill University in Montreal a bullet was located in a man's leg by means of this photography. Similar reports have reached us from Europe. Several hospitals in this city intend to put in an outfit suitable for the production of the X-rays. The surgeons expect much help from this remarkable discovery, and the experimental results obtained in this country so far seem to hold out a very bright prospect.

But surgery is not the only profession which is going to reap the immediate benefits from the practical application of this discovery. Metallurgy and mineralogy expect to overcome some of their old difficulties with the aid of the X rays. Various minerals have a various degree of opacity for these rays, and it is not at all difficult to distinguish a real gem from an imitation. The occlusion of metals is

particularly easy to detect, since metals seem to be more opaque than other substances. But even the metals themselves have a various degree of opacity, as has been already pointed out. Hence, if two metals are mixed to make an alloy, and the mixture is not perfectly homogeneous, it would be an easy matter to detect the want of uniformity, provided, of course, that a sufficiently thin plate is cut from the sample to be examined: thick plates are too opaque to permit an appreciable part of the X-rays to pass through. It is, therefore, not quite clear to the writer how this new method of photography can be employed in its present stage of development to detect flaws in steel guns and armor-plates, unless these rays are made much more powerful than we have been able to make them so far, and unless also we discover photographic plates which are much more sensitive to these rays than the plates now in the market. The author confesses his belief, however, that we shall, in all probability, soon reach both these improvements. A sufficiently long exposure will, even now, as the writer knows from his own experiments, reproduce the various details in the structure of a body. So, for instance, the photograph of a pair of spectacles in a leather case and separated from the plate by a thin sheet of ebonite will, with sufficiently long exposure, show the curvature of the lenses. The photograph of an aluminum medal will sometimes come out so neat and well-defined as to show the lettering and the figures,—that is, in the negative. In the printing this fine detail is not always clearly shown. But it must be remembered that we are only at the beginning of a new art. We hope, and with reason, that this new photography will reveal the interior structure, not only of dead matter, but also of living organisms.

The photographs accompanying this article explain themselves.

Since writing the above I have been able to collect additional facts which seem of sufficient interest to merit mention.

The apparatus described above was discarded as too complicated and too severe on the tube. A six-plate Holtz machine made by the Galvano Faradic Company of New York was tried and gave complete satisfaction. The Röntgen effect with such a machine is sufficiently powerful, and the wear on the tubes is small. In fact, they seem to improve with use, instead of deteriorating. The tube should be connected in series with the outside coatings of the two jars, and the capacity of the jars should not be too large for the size of the tube. With a pear-shaped Crookes tube of 5 inches diameter half-pint jars give excellent results. A cylindrical vacuum tube without internal electrodes, but with external tinfoil coatings at the extremity of the tube, will do very well as a substitute for a Crookes tube. The

vacuum should be as high as anybody can possibly obtain. This is one of the good things of which we cannot have too much,—at least with the methods of exhausting now employed in this country. It should be observed that these methods are perfectly wretched.

Regarding the detail of the things photographed, it is important to observe that Röntgen photography acts differently from ordinary photography. We cannot speak here of over-exposure, unless we specify that it is over-exposure with regard to certain parts which are exposed. Take, for instance, the shadowgraph of a number of objects enclosed in an aluminum cigar box. With a short exposure the details of the structure of the box appear, but those of the enclosed objects do not. With a long exposure the box itself is almost invisible, but the details of the enclosed objects appear. A still longer exposure will make the things enclosed in the box disappear one by one. The most opaque will remain longest. Again, consider the photograph of the human hand. A short exposure gives nothing but the flesh. A little longer exposure brings out the nails. Still longer, and the skeleton begins to appear, whereas the flesh begins to disappear. Still longer, and nothing but the bones appear the various parts being accurately represented in their relative opacity. A still longer exposure will make the various parts of the skeleton disappear one by one, according to their relative opacity. A sufficiently-prolonged exposure would reveal opaque objects concealed in the bone itself. There is no doubt that by a sufficiently long exposure the homogeneity of not excessively thick metal plates can be examined with considerable accuracy.

M. I. P.

February 18, 1896.

THE RAILROAD FACILITIES OF SUBURBAN NEW YORK.

By Foster Crowell.

"NEW York is full of Indians," I heard a sailor-man say in a cable-car the other day. "I've seen heavy weather," he continued, swinging on his strap—"the life-line," he called it—as we were hurled in several new directions at once, "but never nothing to lay over this; there ain't no civilized people lives here."

To say that New York is not civilized in this regard is to imply that somewhere there exists a satisfactory metropolitan transit system.

It is questionable whether a broad statement like that would pass unchallenged in application to any place. The London arrangement is very convenient for its enormous general suburban traffic; and yet it comes far short of an ideal system. Certainly it leaves much to be desired from our point of view; but it will be worth our while, presently, to examine it briefly as a starter, so decidedly is it in advance of anything we have in the United States.

But first let us see where we stand.

It is perhaps a misnomer to speak of the suburban railroad as a problem; it would be more accurate to consider it as an evolution in progress. Suburban traffic has grown up chiefly along the main stems of the railroads that were projected for interurban business only, often without thought of the former. Of course, on some of the lines where the suburban development has been most marked considerable attention has been bestowed upon it; and, so far as has been possible by local improvements, additional tracks, and more frequent trains, much stimulus has undoubtedly been given to the building up of suburbs. And this seems to be becoming more and more general. But the natural result has been that the development has taken place along narrow radial strips, extending out twenty-five or thirty miles, instead of in a more compact occupation of concentric belts. For the purpose of this article, a suburbanite is one residing within thirty miles of New York City Hall and coming to town regularly for business or pleasure. Thirty miles has been selected as the radius vector for two reasons: the first being that it just takes in all the important towns and villages that depend chiefly on New York; the second that, with improved facilities of transportation, it seems likely that all except

obviously undesirable country within the thirty-mile circle will become thickly settled before much suburban occupation takes place outside of it. Into this question the element of time spent in the daily journeys enters largely, and there are other natural controlling causes. The existence of attractive nuclei already established on the farther confines of this territory will have an important effect upon the distribution of new population, which otherwise would now tend to concentrate nearer the city. Sketching it roughly, the thirty-mile circle touches Bound Brook and Morristown on the west; Stamford, Oyster Bay, and Babylon on the east; Tuxedo and Sing Sing on the north; Long Branch and New Brunswick on the south. Its full area is twenty-eight hundred and twenty-seven square miles; deducting the areas of New York, Kings county, Jersey City, and Hoboken, as well as the areas of water surface and ground unsuitable for human habitation, there remain not far from fifteen hundred square miles. How much of this will be strictly suburban can only be guessed at. A considerable portion of it will be urban in many respects,—as Newark is, for example; but Newark is largely dependent on New York, and a large percentage of its population do business in the metropolis. Let us assume that eventually sixty per cent., or nine hundred square miles, will be occupied for residential purposes.

We must now guess again as to the probable density that a suburban population will attain. This is a question of some difficulty, but it may be solved approximately in several ways. For one way I have taken the present condition of the Oranges as about the average, or normal, of all the suburban territory of the future; this does not mean that either the city of Orange or the township of East Orange has stopped growing, but merely that the combined population of all the Oranges has about reached an average suburban density. This, of course, is largely a matter of opinion, but will serve as an illustration. We find that there are, on the average, about five thousand people to the square mile. Multiplying this number by the number of square miles (900), we have four and a half millions for a hypothetical suburban census of the future. This is to be taken only as a crude approximation: there are absolutely no data on which to base either the rate of growth or the law of distribution. Suburban populations are sporadic, so to speak; they reflect the growth of the metropolis, but are not of it. If, by a miracle, real rapid transit should be secured for the outlying parts of the city, they would be built up at the expense of the further suburbs; whereas, if the railroads provide adequate suburban facilities, and if the rapid-transit question continues to be dealt with as of yore, the suburban development will be stimulated greatly, and will doubtless advance with increasing strides.

We reasonably may conclude that the suburban territory within the thirty-mile radius is ample for the development of very many years, and it is a region so diversified between the seashore on the one hand and the mountains on the other that it furnishes, besides abundant space for homes, most attractive resorts for health and recreation. In these natural advantages no modern city can compare with New York, but it remains for future enterprise to develop their dormant possibilities. We have to deal in this article with only one feature of the future development, as a basis for which it will be interesting to study the railroad map on pages 1032 and 1033. It is evident that there are already a sufficient number of main stems to serve a very large proportion of the entire area, provided adequate means of distributing the suburban traffic are supplied. Facilities are means of easily getting from place to place, and, if there are any New York suburbanites provided with them at present, they keep the matter to themselves. This does not involve lack of excellence in the railroads and their general service in other respects; but the fact is plain that in this particular respect it would be difficult to find a more poorly-served community. Despite the many radiating lines of steam roads and the rapidly-spreading electric systems, New York has no adequate suburban facilities, because of the difficulties of reaching the railroads themselves. For many years the New York Central & Hudson River Railroad has endeavored to persuade a somewhat skeptical public that it was the only one having a railroad station in New York city. This somewhat tiresome reiteration is literally true in a sense. Instead of others, we have the ferry terminals, the use of which by the suburban public involves an enormous waste of time, accompanied by discomfort and often by grave risks. Nevertheless, the ferries will continue to be used. Where New York has ferries, London has a cordon of vast terminal stations. In order to make the contrast clear to the general reader, I have prepared a map of New York below Seventieth street, and on it have imposed the circumference of an ellipse whose major axis is somewhat over five miles long and its minor about half that. The same ellipse placed upon the map of London, with its major axis running east and west instead of north and south, would inclose no less than eighteen terminal stations of all the railroads entering London, not counting the thirty-two stations of what is known as the "inner circle" of the underground railroad, which also lie within the ellipse. The great terminals of King's Cross, St. Pancras, Euston, Paddington, Victoria, Waterloo, London Bridge, and Fenchurch Street are situated upon the circumference of the ellipse, while Charing Cross, Ludgate Hill, Holborn Viaduct, Cannon Street, Broad Street, and Liverpool Street are close to its

Ringwood
Suffern
Spring Valley
Clarkstown
Nyack
Stockholm
Ringwood Jc.
Mahwah
Nanuet
Oak Ridge
New Foundland
Charlotteburg
Midvale
Ramseys
Wanaque
Oakland
Montvale
Pearl River
Tappan
Crystal Lake
Pompton
Wortendyke
Allendale
Hillsdale
River Vale
Hibernia Jc.
Butler
Bloomingdale
Midland Park
Westwood
Ridgewood
Glen Rock
Fairlawn
Hibernia
Mt. Hope
Pequannock
Hawthorne
Oradell
Closter
Lincoln Park
New Milford
Mt. Pleasant
Rockaway
Montville
Boonton
Paterson
Dover
Denville
Cedar Grove
Great Notch
Clifton
Hackensack
Mt. Tabor
Parsipany
Pine Brook
Franklin
Passaic
Lodi
Garfield
Troy
Verona
Montclair Hts.
Little Ferry
Caldwell
Up. Montclair
Carlstadt
Morris Plains
Whippany
Watchung
Montclair
Nutley
Rutherford
Glen Ridge
Avondale
Lyndhurst
Kingsland
Morristown
Livingston
Bloomfield
Sobo
Bellevine
Arlington
Convent
Llewellyn
Orange
Madison
East Orange
South Orange
Roseville
Irvington
NEWARK
Chatham
Millburn
Summit
Hilton
Springfield
Marion
JERSEY CITY
Basking Ridge
West Summit
Lyons Farm
Lyons
Murray Hill
Salem
Waverly
Gillette
Stirling
Scotch Plains
Westfield
Elizabethport
NEW YORK BAY
Fanwood
Picton
Elizabeth
Bayonne
New Brighton
St. George
Plainfield
Rahway
Tompkinsville
Dunellen
Matawan
Stapleton
Clifton
Concord
STATEN ISLAND
Bound Brook
South Plainfield
Carteret
Port Richmond
Meadow Park
Richmond
New Dorp
Gifford
Metuchen
Woodbridge
Perth Amboy
Annadale
Huguenot
Stelton
Bonhamtown
Prince's Bay
Millbush
Raritan
Tottenville
New Brunswick
South Amboy
Raritan Bay
Sandy Hook
Sandy Hook Bay
South River
Morgan
Cliffwood
Port-Monmouth
Keyport
Old Bridge
Matawan
Monmouth Jc.
Haziet
Atlantic Highlands
Middletown
Navesink Highlands
Dayton
Spotswood
Fairview
Morganville
Jamesburg
Seabright
Wickatunk
Holmdel
Hoffman's
Cranbury
Bradevelt
Red Bank
Monmouth Beach
Englishtown
Shrewsbury
N. Long Branch
Tinton Falls
Long Branch
Eatontown
West End
Electric Roads
NEW YORK & RARITAN R.
NEW YORK & LONG BRANCH R.
LEHIGH VALLEY
PENNSYLVANIA
DELAWARE
RARITAN
30 Miles from
City Hall

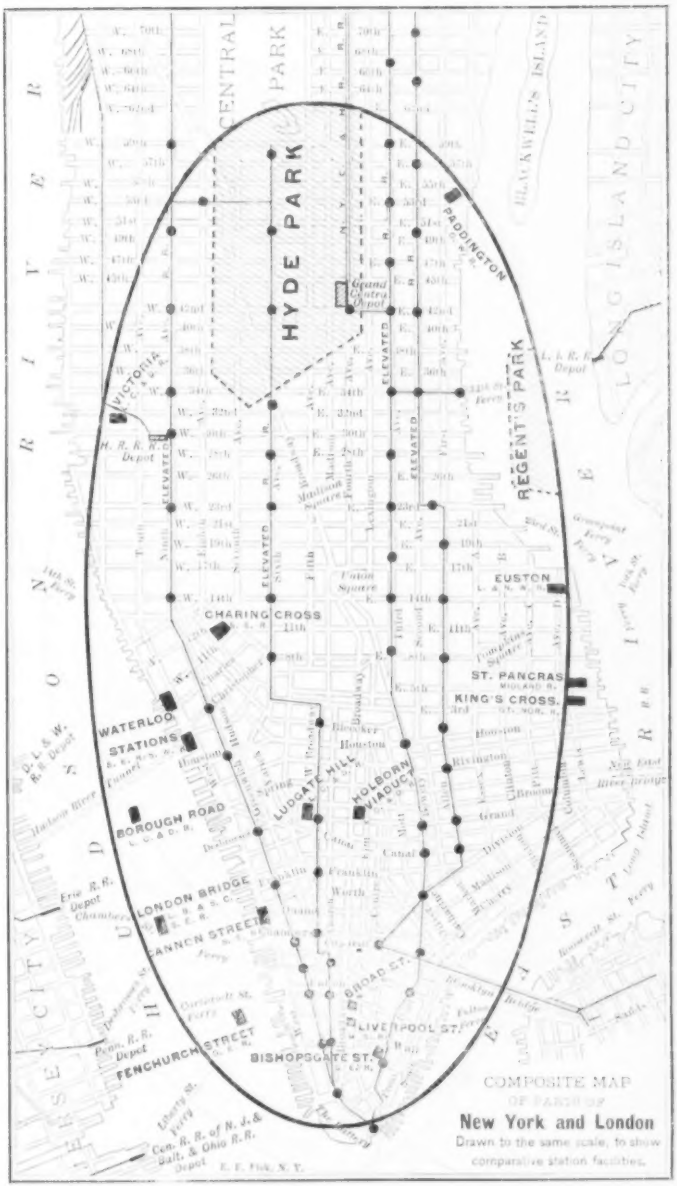
30 Miles from N.Y. City Hall
Sing Sing
Pleasantville
New Canaan
CONNECTICUT
Springdale
Greenbrook
Stamford
Tarrytown
Irvington
Greenburg
White Plains
Port Chester
Dobbs Ferry
Hastings
Scarsdale
Rye
Greenwich Pt.
LONG ISLAND SOUND
Yonkers
Bronxville
Mamaroneck
Larchmont
Riverdale
Mount Vernon
New Rochelle
Spuyten Duyvil
East Chester
Bartow
Bay Chester
Van Nest
West Farms
Bayville
Oyster Bay
Locust Valley
Glen Cove
Sea Cliff
Cold Spring
Jericho
Great Neck
Little Neck
Douglaston
Bay Side
Whitestone
Flushing
Astoria
L. City
Corona
Newtown
Creedmoor
Hyde Park
Mineola
Westbury
Central Park
Queens
Hollis
Jamaica
Hempstead
Garden City
Bethpage
Farmingdale
Amityville
BROOKLYN
Woodhaven
Morris Park
Ozone Park
Springfield
Valley Stream
Pearsalls
Merrick
Massapequa
Rockville
Baldwins
South Oyster Bay
Flatbush
South Woodhaven
Wood-haven
Flatlands
Lawrence
Cedarhurst
Far Rockaway
Ft. Hamilton
Bath Beach
Coney Island
Oceanus
Long Beach
Jones Beach
ATLANTIC OCEAN
RAILROAD MAP
OF
NEW YORK CITY
AND VICINITY.
Scale of Miles

major axis: the inner circle, which is very far from a true circle by the way, skirts it so as to touch all except the Waterloo and London Bridge stations, which, being on the Surrey side, require special communication with the "city." For each of the other terminals there is a corresponding station of the underground railroad, either in direct connection or near by. There are also intermediate stations, and, as some main-line trains make use of the underground, these add to the number of the railroad facilities of suburban London. The route of the proposed Central London Electrical Railway, an underground way from the Bank of England to Shepherd's Bush at the extreme west of London, will extend along the major axis of the ellipse. The City and South London Railway, also underground, commences at the Monument and passes under the Thames to the southeastern suburbs. The South Eastern Railway Company is now engaged, at a cost of three million dollars, in constructing an underground electric line one and one-half miles long, mostly in tunnel, from Waterloo Station to the "city." The limits of this article do not permit us to go into the London system in detail, but we must not fail to remember the cheap and all-pervading cab, for which New York streets will, it is hoped, be suitably paved some day.

In order to see what New York would look like with a similar equipment of railroad stations, I have plotted the London terminals in their proper relative positions upon the New York map. It is interesting to note that Hyde park and Central park occupy analogous positions with reference to the "city" and to Wall street.

Our composite map shows that, with equal facilities to London's, New York would have seven terminal stations south of Chambers street and eleven more below Fifty-ninth street. Now let us imagine a continuous double-track railroad (with more than two tracks in places), with trains circulating in both directions and reaching all these terminals, and we shall have the London system. If we supplement it by still more tracks, by several cross-town tunnels, and one or more up- and down-town lines with stations at the intersections for distribution by shuttle-trains, we shall have in skeleton what, in my humble judgment, New York requires, and ultimately will have, for suburban facilities, some of the terminals being railroad stations and others ferries or other water routes. Finally, to complete our picture, we should add loops corresponding to the London "outer circle" and other circuits touching the inner circle but not always combining with it, because on any short-distance line train-capacity is relatively much greater than track-capacity.

It is a question worthy of deep consideration whether a system of separate terminals would in any given case be as satisfactory as a union


CENTRAL PARK
HYDE PARK
BLACKWELL'S ISLAND
LONG ISLAND CITY
PADDINGTON
REGENT'S PARK
EUSTON
ST. PANCRAS
KING'S CROSS
CHARING CROSS
VICTORIA
WATERLOO STATIONS
BOROUGH ROAD
LONDON BRIDGE
CANNON STREET
FENCHURCH STREET
BISHOPSGATE ST.
LIVERPOOL ST.
BROAD ST.
LUDGATE HILL
HOLBORN VIADUCT
ELEVATED
Grand Central Depot
Union Square
Madison Square
Madison Square Garden
Erie R.R. Depot
Penn. R.R. Depot
Con. R.R. of N.J. & Balt. & Ohio R.R. Depot
L. & N.W. R.R. Depot
H. R. R. R. Depot
L. I. R. R. Depot
COMPOSITE MAP
OF PARTS OF
New York and London
Drawn to the same scale, to show
comparative station facilities.

terminal; this requires to be studied from several points of view, but, so far as New York city is concerned, one union terminal would be inconveniently large and practically out of the question. Probably each of the suggested terminals would be a union of several lines, and doubtless would require all the space that could be secured in one enclosure. Rapid and convenient circulation between the separate terminals, and from those terminals to the business portions of the city, would be a *sine qua non*, whether it be a part of a so-called rapid-transit system, or an entirely distinct distributing system, such as I have outlined above. If the latter should be adopted, it should embrace as much down-town territory as possible; it should not occupy a central position, because that would involve the greatest degree of congestion with the least extent of accommodation. This is on a theory totally opposed to that upon which the rapid transit commissioners have located their line under Broadway. Below Fourteenth street a system affording the "greatest good to the greatest number," and furnishing the needed relief from the congested condition largely due to the absence of quick communication anywhere except in the immediate vicinity of Broadway, should run not far from the river fronts and be continuous. A natural and probable adjunct to such a system, underground or elevated, would be concentric outer tracks for suburban trains running directly in from junctions with their own lines, passing around the circulation and out again, and stopping at stations common to both the inner and outer tracks. In some places cross-lines would form cut-offs or short-circuits, and there would be transfer stations at intersections with other rapid-transit systems, if such should come to be provided.

Of course, we cannot have railroads coming into New York *ad libitum*, on account of the rivers: but at no distant day a number of them will probably find they can no longer afford to stay out. In fact, this discovery appears to have been made already, but there is great difficulty in getting in. It is conceded now by some good authorities that the abandonment of the former station of the Hudson River Railroad at Chambers street, and the down town stations of the Harlem and the New Haven lines, was a mistake. The same error of judgment was made in Philadelphia when the Pennsylvania Railroad removed its terminus to West Philadelphia, to be corrected a few years later at an enormous expense by its re-entry to Broad street. It is idle to theorize in regard to what might have happened had the old New York stations been retained and the railroad service fully developed in connection with them. For many years New York has been aware of its deficiencies, for which the authorities have suggested but one remedy,—rapid transit to the northern part of the city. Pri-

vate parties have been busy with other plans—some extremely good and others entirely impracticable—for crossing the rivers, either under or above. The schemes that have been proposed for tunnelling under the North and East rivers are too numerous to specify here. Out of them all there is at least one very excellent project for a deep tunnel from Brooklyn to Jersey City with intermediate stations in New York. It is proposed to operate it independently, with electricity. It would be about two hundred feet below the surface, and would be reached by elevators. Nothing need be said here in regard to tunnels for bringing the present steam railroads under the rivers to an underground terminal; such schemes make interesting reading, but will not bear the test of expert investigation.

The bridge that was begun a year or so ago across the East river at Blackwell's Island is for the purpose of extending the Long Island system to a terminal station between Second and Third avenues, not far from Sixty-fourth street. Two distinct projects for bridging the North river have in view terminals to be used by the New Jersey railroads. Without hazarding conjectures as to the time of completion of any of these bridges, we may assume that at some future day they will be accomplished facts. When they are, New York will have some suburban facilities worthy of the name; there would then be a fair beginning of a separate terminal system, with four stations situated within a circle two miles in diameter, the center falling within the Grand Central Station. Lying just outside of this circle is the old Thirtieth Street station of the Hudson River Railroad, which, in all probability, will soon come into more important use for suburban passenger traffic than at present. Supplemented by outlying stations beyond the Harlem, the above group would have a vast aggregate capacity, and would provide for railroad communication to all the suburbs, including Staten Island, excepting those lying to the southeast, which probably will be better served by means of bridges to Brooklyn and the Brooklyn elevated railroads, assuming the trains of the latter to be run directly over to New York. The "new East River bridge" at Delancy street, which is about to be begun, will have, it is understood, two tracks for elevated railroads and four for trolleys.

So far we have been dealing with the most important end of this subject, for, with suitable provisions within the city for reaching the suburbs, the accommodations in the latter can easily keep pace with them. But it will be interesting to glance briefly at the suburban end also, and observe the new possibilities of development on the steam roads by means of electricity. In the references to steam roads I do not mean to imply that the suburban traffic upon them necessarily will continue to be moved directly by steam; I retain the common desig-

nation to avoid any confusion with electric lines pure and simple; but it now appears very probable that there may be a general substitution of electricity upon the steam railroads as applied to suburban traffic, for which service it is peculiarly adapted. The present railroad facilities in the suburbs themselves are so diversified that it is difficult to speak generally and justly in regard to them. There has been a visible improvement within the past few years. There is still much to be desired, but very much depends upon the road. My Plainfield friends who go out in the "club car" probably would not agree that they are at all neglected, but any resident on Long Island would doubtless accept the proposition without question.

Some of the steam roads are not alone neglectful, but also singularly lacking in perception: they make no apparent effort to attract suburban travel, but deliberately act in a manner to discourage it, or even to drive it away to other lines. One railroad's stupidity in this respect is monumental: its management appears to have erroneously supposed that, because they, as a matter of fact, absolutely controlled the carrying trade of their territory, they therefore had no competition, and could do as they liked in maintaining excessive fares, furnishing poor accommodations, and even imposing gratuitous and unnecessary annoyances upon the public, without fear of losing their patrons. They seemed quite unaware of the existing powerful competition exercised by railroads leading in other directions or of the possibilities of their field being invaded by the ubiquitous trolley. They have, doubtless, ere this, sincerely regretted their mistake, and are paying very dearly just now for their lesson, which, it is to be hoped, they will profit by. The problem of supplying general communication to the suburbs is at present involved in considerable difficulty, due to the natural tendency of the trolley companies to parallel the steam roads and take the latter's business. This, while it has the effect of reducing fares, reacts on the community by forcing the steam roads to curtail their train service. In such cases the net result is not satisfactory to the public.

To escape from the ruinous competition, the steam roads will be obliged to occupy the field of the trolley themselves, either by owning the surface lines or by introducing electricity on their own lines. Both of these methods have been resorted to recently in the case of the New York, New Haven & Hartford Railroad, and it is extremely probable that the next few years will witness considerable modification in the trolley line development. On account of the limitation of speed that must be observed on streets and public highways, there is a corresponding limiting radius of operation for such lines. For short distances the lost time to the average traveler by the trolley does not

weigh in the balance against lower fare; but with each additional mile the disadvantage becomes greater, and a point is reached beyond which it does not pay to use the trolley in preference to the steam road. In cases where trolley lines are built on independent right-of-way, and where the speed restriction does not exist, the competition is mitigated usually by the fact that the fixed charges for the electric road will be as great as, or even greater than, those of the steam road for the same distance.

Recent successful adaptations of electricity on steam railroads remove whatever doubts have heretofore existed as to the feasibility of electrically operating full-powered railroad systems. Most prominent and successful and convincing among these is what is known as the Nantasket Beach experiment, made during the past summer on the New York, New Haven & Hartford Railroad, which consisted of relaying twelve miles of double-track line in regular service to accommodate an electrical equipment while improving it for the steam locomotive service. Scarcely less demonstrative, though in a different way, is the highly successful performance of the 95-ton electric locomotive which is in constant service in Baltimore to haul entire trains, including the steam locomotive, through a tunnel. A high electrical authority has recently come out with a striking suggestion for the adoption of electricity generated by gas-engines for main-line operation of the Pennsylvania Railroad, claiming that only one-eighth of the present coal consumption "would be required, effecting a saving of four million tons of coal per year, now costing the railroad company above five million dollars,—a saving which would justify a large enough capital expenditure to cover the complete equipment of the railroad."

Ample experience has demonstrated that electric roads can be successfully operated with gradients and curvature far in excess of what would be feasible on a steam road, and for the purpose of suburban development the former are most admirably suited. There are numerous attractive and delightful locations close at hand, which have been heretofore practically inaccessible to the steam roads, but which can be reached by electric laterals in connection with them. With the multiplication of safe, speedy, and comfortable means of reaching the suburbs, the most powerful reason for overcrowding the city—necessity—will largely disappear; better opportunities for living and for enjoyment both to the suburbanite and the city man will be afforded. The future railroad facilities of suburban New York is a subject of vast importance to all her people, and calls for, and will undoubtedly repay, far more serious attention on the part of the steam railroad companies than it has received.

STANDPIPES FOR FIRE PROTECTION AND STREET FLUSHING.

By Louis L. Tribus.

WITHIN the recollection of the present generation the needs of large cities in the matter of water-supply for fire protection and sanitary requirements have undergone so complete a change that methods fully adequate twenty years ago are as little suited to the present as the early locomotives would be for hauling the modern fast express train.

The development from the bucket brigades, through the hand-pumping engines down to the present superb steam fire engines and trained fire departments, is an interesting one; but it is perhaps a question whether we have not reached a period where even better facilities for fire protection are a necessity.

Most large cities have been, or are being, provided with water-supplies adequate for all domestic and manufacturing purposes, under either gravity or pump pressures sufficient to raise the water to the top of buildings seven or eight stories in height; such buildings are well within the reach of fire streams from a good fire engine, also, so that all necessary conditions are satisfied.

But buildings are fast reaching an average of ten to twelve stories, many having nearly twice that number; and, while we do not forget that fire-proof construction improves as the roofs travel skyward, the fact is daily becoming more apparent that these tall buildings are beyond the reach of due protection from the public fire departments.

To attain necessary protection there must be a full water plant in each building,—piping, hydrants, hose, tanks, pumps, and boiler, and not infrequently artesian wells to furnish a supply of water independent of the public service.

In the aggregate these plants involve an immense investment of capital; yet such expenditure is warranted by the saving in insurance premiums under "full protection" clauses.

Fortunately, these tall buildings have so seldom been subjected to the test of fire that the complete inadequacy of present fire methods has not been proven; still, we know that at large fires, in even moderate-sized structures, it is necessary to couple two or more engines on the same line of hose or "water tower," in order to deliver sufficient water at a height where it can be effective.

What, then, could be done on the "sky scrapers," or even in the

buildings of fourteen or fifteen stories, if their own protective agencies should break down? Nothing but wait until the fire should burn to a point within reach of the fire department, before which time the building probably would collapse through distortion of its iron frame by the heat.

Few large cities have a high-pressure water service. In the past this has been lacking largely because a low-pressure system met all requirements of domestic supply,—fire service and boiler use, other uses not having become fully apparent; in the present it is lacking because of the expense attending new installations.

Conditions are now changing: as already indicated, buildings are rearing their heads above the flow-line of reservoirs, and outreaching the capacity of established pumps. Business men recognize the economy of centralized power stations and distribution of energy to meet the actual daily and hourly needs of small powers. Communities are beginning to appreciate the value of fine street pavements, and the better sanitary condition and moral effect consequent on keeping them at a maximum of cleanliness.

To meet these changes, mechanical ingenuity has so far improved what may be called "municipal" machinery that work costs now only half as much as it did a few years ago. Pumping engines of high class, occupying small space, work with almost human intelligence under heavy strain, and show less tendency than their human prototype to break down under such tension. Again, decreased cost of iron and improvements in manufacture have contributed in making serviceable cast-iron pipe for high pressures, thus rendering feasible the construction of large plants at relatively small cost.

The use of steel frames in building construction permits the support of heavy weights at high elevations without devoting so much valuable ground space to masonry supporting walls as would have been necessary a few years ago. Now the masonry walls are needed only for ornament and protection of the interiors from the elements.

This very possibility carries with it the necessity for improved fire-proof construction, high-speed elevators instead of stairs, high-pressure water service, and forced heating and ventilation effected by steam, electric, water, or pneumatic power. To meet these requirements, various methods have been adopted. For electric service the reliance is mainly on central stations; for steam, on isolated plants, except in one noteworthy instance,—New York: for water, on isolated outfits, except in the case of one large system in London; for pneumatic power, almost entirely on individual plants.

It is universally conceded that, wherever feasible, there is advantage in storing water close to, and at sufficient elevation to flow by

gravity to, the district that is to use it, thus discounting in a measure accidents to conduits or pumps. All will probably concede, also, that, in case of fire, the system which at the shortest notice will deliver full streams of water at the highest pressure is the best, the first few minutes often determining the result of a conflagration.

The tendency of growth in most cities is to occupy first the low-lands, spreading to the hills only when driven by necessity.

Many of our largest cities are at a considerable distance from any really high ground; most are near some large river or sea. What follows therefore? One of three things: either a water service by gravity from a distant source, usually producing rather low pressures; a pumping system delivering directly into the mains; or a combination of the two,—pumping from the point of delivery of the gravity supply into the mains direct, or to small reservoirs or tanks, of various capacities, raised to sufficient elevation for the water to flow by gravity to consumers. Of course there are many variations and combinations, but these cover the general conditions of public water service.

The point of special interest in this connection is for cities of the first class. That which will save hundreds of thousands of dollars annually will warrant an expenditure of great sums for installation of the saving plant.

One would have to draw largely on the imagination to estimate the saving in a city like New York or Chicago, could steam fire engines be abolished and hose companies substituted, could individual private pumping stations in private buildings be dispensed with, and could the hundreds of buildings paying high insurance rates be so protected as to place them in the class of "good risks," with consequent reduction of annual premiums.

In many cases such calls on the imagination might produce too severe a strain, yet in this one the results outlined for attainment seem feasible.

Let us suppose, first (not outside the pale of possibility), that the *quantity* of water supplied is fully sufficient for all needs, but that the *pressure* is inadequate for direct fire protection,—a very frequent case. One solution would be to establish at scattered points in the city separate pumping stations, drawing water from the larger supply mains and delivering it under high pressure into large tanks at high elevations, whence it would flow by gravity through the distribution pipes to all classes of consumers in the district. These districts should be separate, yet connected, so that at short notice, in an emergency, one could supply another also.

The districts should be so arranged that pressures throughout could

be practically uniform, and compact, so that no long distribution lines would be needed.

Under such a service, every hydrant, all the time, would be, in effect, filling the place occupied by a steam fire engine, a few minutes after the rising of an emergency requiring its use.

By placing at each tall building a rising pipe,—inside or outside, as might be preferred,—with nozzle connections at each floor and hose attached ready for instant service, and with hose connections at the ground level, it would be possible in a very few moments to connect with the nearest street hydrant and have water flowing at any floor required without the trouble and delay incident to stretching long lines of hose and hauling it to the upper floors of buildings.

Better yet would be to have the street mains connected direct to these rising pipes, so as to be free of even the first delay in arrival of a hose company. These details, however, need not be discussed here: the subject is too wide to permit of more than suggestion at this time. This is no new principle or theory, but one which has for years been in use in isolated cases, though it has seldom entirely superseded the steam fire engines.

These stand pipes have been built in three main classes: a large wrought-iron or even wooden tank raised on a trestle; the same tank supported upon and enclosed by substantial masonry walls, and made an architecturally attractive structure; an immense wrought-iron or steel cylinder, filled with water from the ground up, in stable equilibrium because of its own weight and diameter.

For a large city these tanks might be of large diameter and occupy the top stories of high office-buildings or warehouses, rentals therefrom bringing a partial or even full return on the capital invested,—the basements being utilized for pumping stations. Here could be installed high-grade, economically-working pumping engines, capable of supplying, not only their own district, but an adjoining one as well, and keeping their own tank continually filled with water, drawing it from the main supply pipes or feeders, the water being delivered thereto either by gravity or by low service engines.

It needs but to call attention to the subject to establish the far greater relative efficiency of such a pumping plant, working under every mechanical advantage, over the peripatetic steam fire engine, whose one aim is to pump water in a hurry, when wanted, regardless of economy.

The benefits from the latter obtain only when in action in the emergency of a fire, while the former would be giving a continual service, and be ready more promptly in the emergency.

A few years since, another use for water under high pressure would

have made a strong argument in favor of such establishment,—*viz.*, the demand for small powers for elevators, ventilating fans, and other light machinery for intermittent service, with the revenue obtainable from such use. But the transmission of electric power has become so universal and convenient that the need for water power is rapidly passing, electricity eliminating, as it does, the necessity of special piping, fixed shafts, and large waste pipes.

Another phase of municipal life now assuming important proportions is the cleaning of streets; the removal not simply of heavy refuse, but of the finely-divided particles of dust, which sweeping machines serve merely to again start in motion, carrying irritation and mayhap disease wherever it lodges. Sprinkling serves but to aggravate, or at best ameliorate, not to cure the condition.

A few cities provided with ample sewer accommodations are alive to the subject, and make use of water in quantity to capture and carry with it these finer matters, allowing the sewers and their flow to do the duty imperfectly done by sweeping machines and cleaning departments. Many notice and rejoice at the beautiful cleanliness of paved streets after a heavy rainstorm; the dirtiness at other times must necessarily be great to show so marked a contrast. Take that same pavement, turn a powerful stream of water upon it from a fire hose, and but a few minutes will be needed to thoroughly wash free and drive before it all the accumulated dust and dirt. Having substantial movable wire screens at the sewer basins, all coarse matters can be collected and removed in a cart.

This cleaning could not be thoroughly done with water under low pressure, except at great expense of time and water; but, with the suggested system, a cleaning gang, with a length of hose mounted on a number of pairs of low wheels, some six inches in diameter, operated by two men, and drawn by a horse, accompanied by a couple of other men to handle the screens, and a cart for the coarse *débris*, could in a few minutes clean a block thoroughly,—walks as well as streets. Attaching the hose successively to the fire hydrants, they could soon cover a very large district.

Night is the proper time for such service, though Paris does some of the lighter cleaning throughout the day as well.

Of course there are times when this method might not be entirely satisfactory; in intensely cold weather, for instance, the ice coatings likely to form might be too great a danger to life and limb, more than offsetting the cleanliness attained. But in the main it seems feasible, and an improvement on what may be called the "dry carriage" system by carts or machines only.

It must be borne in mind that pumping all this water under high

pressure will cost large sums of money; the installation of a number of separate water systems dependent on great supply mains will take large capital; but would it not be fully warranted by adequate fire protection furnished, with the consequent reduction in insurance premiums, and by a thorough cleaning of streets, with the consequent lower rate of mortality.

Thus far it has been assumed that the supply of water was not only serviceable in purity, but practically unlimited in quantity, delivered without great expense for filtration or other means of purification. The reverse is not at all unlikely. In such cases, while the fire supply might properly be drawn from the purer waters, that for street flushing could not be economically so taken. Therefore it would be better to subdivide the service, delivering pure water at low pressure for domestic and boiler use, and establishing separate systems of mains for the high-pressure service for fire protection and street flushing, using untreated river water, or even salt water, if the city be near the sea.

The use of salt water, while more troublesome from its action on metal, is not at all impossible: coatings of preservative varnish will very fairly protect iron from its action, and working parts of pumps can be of bronze to resist corrosion.

There are some cases where it might be better to adopt the two systems, — low pressure for domestic use and high pressure for fire protection and street flushing, — from reasons of operative economy, in spite of the larger first cost of parallel pipe systems; but of that this article need not treat.

Some will no doubt say that these same results can be attained without using standpipes or towers at all, by pumping directly into the mains, and meeting fluctuation of consumption by regulating the speed of the pumps. This undoubtedly is practicable, but only at a sacrifice of efficiency, and does not provide the reserve of water held in the tank for sudden extra draught or a temporary break in the machinery, — points worthy of careful consideration.

Pressures considered here as relatively low and high are respectively below sixty pounds and from one hundred to one hundred and twenty-five pounds per square inch.

Undoubtedly there are objections to the standpipe system of water service in large cities, but a study of their conditions, daily becoming more serious, indicates the necessity of methods better adapted to serve the purposes of fire protection and street cleaning than any hitherto used on a large scale. The separate district high pressure service suggested herein seems to offer some of the advantages desired.

ARTISTIC ENGINE-ROOM INTERIORS.

By E. T. Adams.

AN engine-room where every decorative detail expresses an appropriate purpose of the designer has a just claim to be classed as artistic. Rooms of this type are a marked feature in late installations of power. This is especially noticeable in the smaller plants, where, largely because of the greater proportion of cost, the equipment and finish of the engine-room have usually been in most unfavorable contrast to those of rooms where the power developed is greater. This tendency in modern practice is not, as it may appear at first, wholly unimportant. It has been in response to just such demands that, in one short quarter-century, types differing as broadly as the Corliss and the single-valve automatic engines have been evolved from the single crude form which was then, practically, the one form available for any and all classes of service.

A more carefully considered engine-room involves some changes in engine design, mainly in the line of greater security against flying oil; but a matter of greater importance is the probable effect on the status of the stationary engineer. So long as the plant was located in some dark, uninviting corner, the engine could pound itself to pieces, or the boiler corrode to the exploding point, and, until disaster came, no one was the wiser. But with the modern type of engine room, easily accessible, neatly, often elegantly, fitted up, always brightly illuminated and scrupulously clean, the conditions are very different. The engine must run smoothly and noiselessly, there must be no jar or vibration, no smirch from flying oil or hiss of steam escaping past defective packing. These are simple requirements, but, to insure their fulfillment day after day, year in and year out, not only must the machinery be of the best, but the engineer in charge must be one who has received a thorough training,—a man of experience and judgment whose heart is in his work,—a man, in short, very different from the so-called engineer common under the old régime.

It certainly has been the common practice for owners of plants of moderate size to assume that the man who would consent to work the longest hours for the least wages was the cheapest man to employ, and this regardless of the advice and warning of engineers and engine builders or the record of disasters and deaths due to incompetence. If awakened pride shall now lead to a better practice, where legislative enactment and the dictates of business prudence have failed utterly, it will be an interesting, if not a unique, commentary on the working of the mind.

There is much to encourage the hope that the tendency of to day may become the settled practice of to-morrow; in effecting this the most potent element will be the pride that an owner takes in the proper appearance and operation of a plant which he has made attractive and which is open to inspection at any hour of the day. It takes years to demonstrate that the skilled engineer is the cheapest man to employ, but a very short trial suffices to show that the less skilled man cannot maintain, in the machinery under his care, the desired regularity and smoothness of action. Looking at the matter from the purely financial standpoint, the records of any engine builder will show that probably eighty per cent. of all repair work is made necessary, not by natural wear, but chiefly by neglect due to the shiftlessness and incompetence of the man in charge of the plant. In other words, an engineer of ordinary skill can, by exercising reasonable care, prevent four out of every five "breakdowns,"—an estimate which is, probably, considerably lower than it should be. It is very hard to give this degree of immunity from delay a cash value, but in many cases, even in small plants, it is a considerable item. Similarly, by careful usage, the useful life of an engine is very greatly increased and the cost of oil and supplies is proportionately reduced.

We overlook an important force in human progress, if we take no heed of the universal pride of man in that which he has creditably accomplished. The pride of the owner in the plant that has been artistically planned and carefully executed is matched by the pride of the engineer in maintaining the brightness and efficiency of the machinery under his care, and the consequences to each are of no mean importance. The intelligent interest of the employer in the plant that he has created will tend toward efficiency and economy in its management, and, in time, result in an appreciation of the duties and qualities of those on whom the actual work of operation devolves. On the employee these conditions enforce a healthy bodily activity and the habit of doing things promptly and efficiently.

For many years—it may be the practice still—the Southern Pacific Railroad Company offered prizes for the best-kept engine in each division,—an honor that was most keenly competed for. The engines certainly presented a magnificent appearance; the bright-work was always shining, the russia iron covering for the boiler clean and clear from spots, the cab tidy, the bell-rope carefully braided, even the running board carefully wiped,—in fact, every detail received thoughtful attention. But, much as the engine was admired, the impressive figure was the fireman, alert, active, out along the running board at each station, touching up a bolthead or band, in his neat cap, polished shoes, and spotless overalls, the figure of manliness. If the system had no

ENGINE-ROOM, HILTON, HUGHES & CO., NEW YORK.

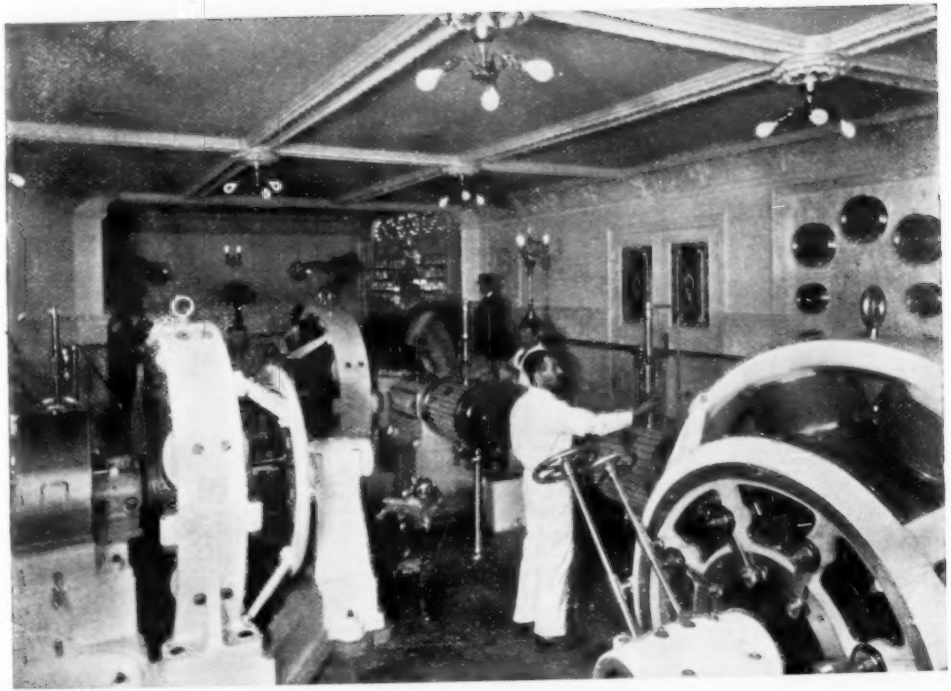
other result than the training it gave the men, it was well worthy of perpetuation.

What is appropriate in the design and finish of the engine room depends on circumstances. The Hilton-Hughes plant, for example, is on one of the main floors of a beautiful store, and manifestly should be in keeping with its surroundings. The plant at Keith's, again, is one of the artistic features of a most attractive theatre. From plants like these, where the expense for decoration alone runs far up into the thousands of dollars, to the modest room with whitewashed walls and a smooth substantial floor, there are infinite gradations, each perfectly appropriate in its place, and all including the same essentials,—perfect cleanliness and an abundance of light, since each of these is essential for the proper care of the machinery, and substantial construction for those parts that must withstand severe usage.

Of modern artistic engine-rooms one of the most beautiful is the plant at Keith's Theatre in Boston, of which general views are here presented. This plant furnishes light for the theatre, including that used for producing scenic effects. A beautifully-decorated and brilliantly-lighted tunnel connects with the main entrance to the theatre, and the place is visited and admired nightly by many to whom an engine-room of this class is a most attractive novelty. The entire room is finished in marble, as is clearly shown by the cuts; unfortunately it is not possible to reproduce the beautiful coloring, or the effects obtained by the tasteful grouping of incandescent lights, to both of which the place is deeply indebted for its artistic effects. The engines are an enclosed type, the Harrisburg Ideal, and it is practically impossible for a drop of oil to be thrown from any part of the machinery,—a fact to which the spotless white of the uniforms of the engineers bears unimpeachable testimony.

There is nothing incongruous in marble wainscot, buhl tables, and potted palms in an engine room where, as here, it forms an integral part of a beautiful entrance, and is in itself an attraction of no mean importance in a place where attractiveness is all-important. The engineering features connected with the concealed piping and the arrangements for conveying oil to the engine room are of more than passing interest, but somewhat beyond the scope of the present article.

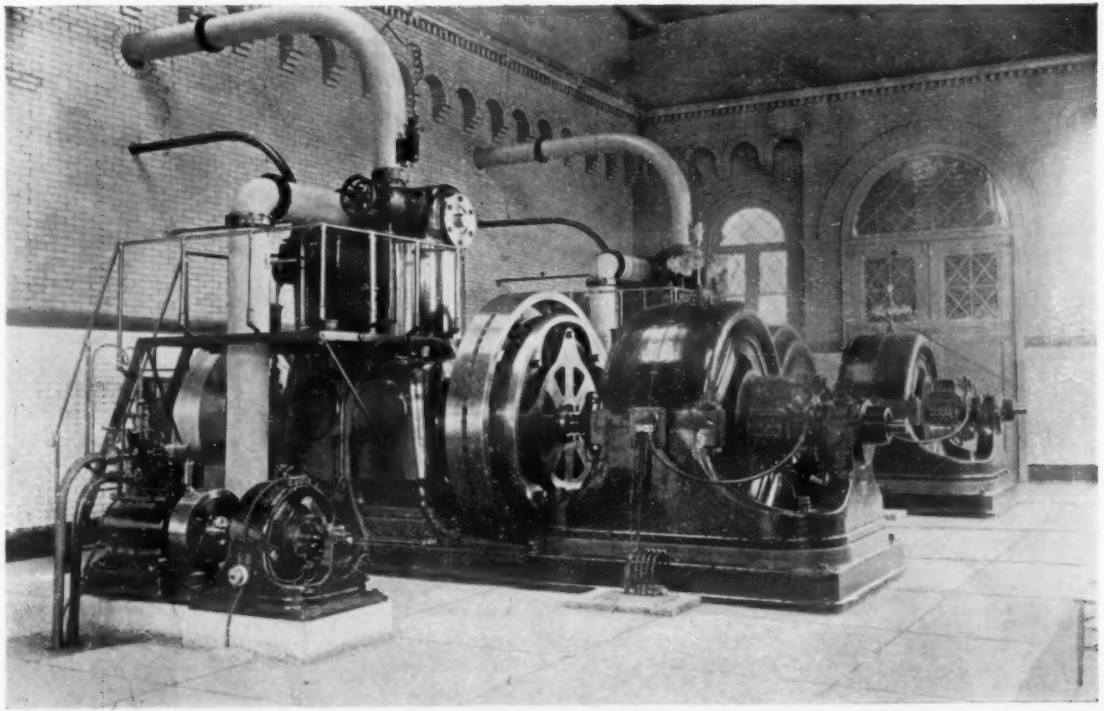
The cuts on pages 1052, and 1053 are from photographs of the power station of the Columbus Central Railroad, of Columbus, Ohio. This station, started with 800 h. p., is intended to, and soon will, accommodate about 2500 h. p. There is no cash value to an engine room as an attraction in this case. The power house is to furnish power for a purely commercial enterprise, and the delightful taste exhibited in fitting it up seems to be simply a way of expressing a love of



ENGINE ROOM, KEITH'S THEATRE, BOSTON.

RECEPTION ROOM AND SWITCHBOARD IN ENGINE-ROOM OF KEITH'S THEATRE, BOSTON.

SWITCHBOARD IN THE ENGINE-ROOM OF COLUMBUS CENTRAL RAILROAD, COLUMBUS, O.

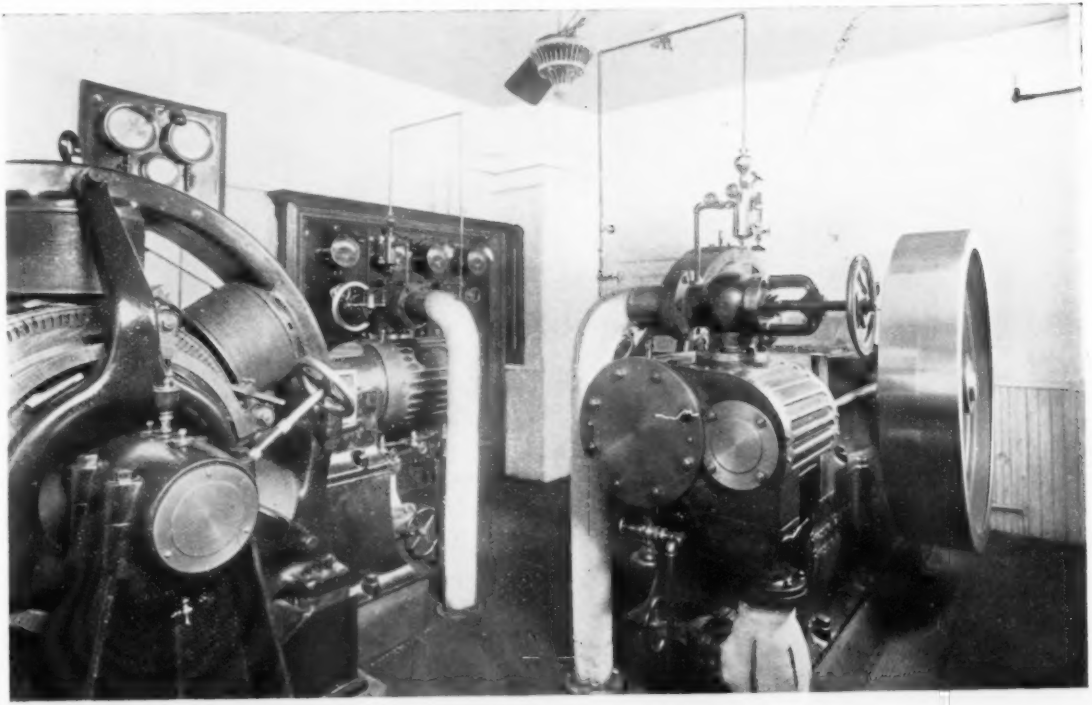


ENGINE-ROOM OF COLUMBUS CENTRAL RAILROAD, COLUMBUS, O.

thorough, honest construction. To that which has been carefully planned and which will endure, we can certainly afford to give an appropriate finish. The building is of pressed brick and cut stone. Inside, up to seven feet in height, there is white enameled tile surmounted by a band of terra cotta; above this the wall is buff pressed brick, and the frieze is outlined with arches and a line of incandescent lamps. The switchboard is of finely-polished mahogany, severely plain, save for some fine hand-carving, which it is impossible to adequately reproduce in cuts of the size here used. Everything is expressive of thoroughness, and it is no surprise to discover that the boiler-room is supplied with economizers and every appliance for getting the maximum number of heat units from the fuel consumed, or that the rails are heavy and the bonding most thorough. Again, we note the enclosed type of engine,—Westinghouse compound this time, but affording absolute security against flying oil. At the present time engines of the same type affording about one thousand additional horse power are being installed, room having been provided for them in the original plan.

In New York city a most beautiful thing of this kind is the plant at the establishment of Hilton, Hughes & Co. The engine-room, which is comparatively narrow, extends for upwards of sixty feet along one end of one of the main floors of the store, this side of the engine-room being fitted for its entire length with columns alternating with plate glass. As in the plant at Keith's, the floor of the engine room is dropped a little below the general floor line, and the glass permits the visitor to overlook the entire installation. The floor is of iron and cement, faced with mosaic tile; the walls of white enamel tile with a dado of figured enamel tile and fringe of moulded tile, and studded with incandescent lamps with ground glass globes. The ceiling is of pressed steel especially designed, enameled white, and relieved by clusters of lamps, both arc and incandescent. The switchboard is of dark onyx, and is most artistically arranged. The engines are of a type not originally enclosed, but the safeguards adopted are effective, and there is no trouble from flying oil. These engines were built by the Payne Engine Co., and, as now built, are practically an enclosed type, although the original design has not by any means been wholly abandoned.

The engine-room of the Hotel Stenton, Philadelphia, is one of the most artistic that I know of. In few plants of its size have the essential details been so carefully and thoroughly studied. Every part is accessible, the piping is concealed. There is good light and good ventilation, and more than all, they have shown rare good sense in not introducing decoration when there was no reason for doing so. The



ENGINE-ROOM, HOTEL STENTON, PHILADELPHIA.

usual practice would be to heat that little room to an unbearable temperature, by leading through it a mass of steam and exhaust piping; then the fair white wall would have been hastily tattooed with some stenciled ornament stolen from a Greek vase, and the result would have been called artistic! I claim that decoration is out of place in the engine-room, unless the *surroundings* demand it.

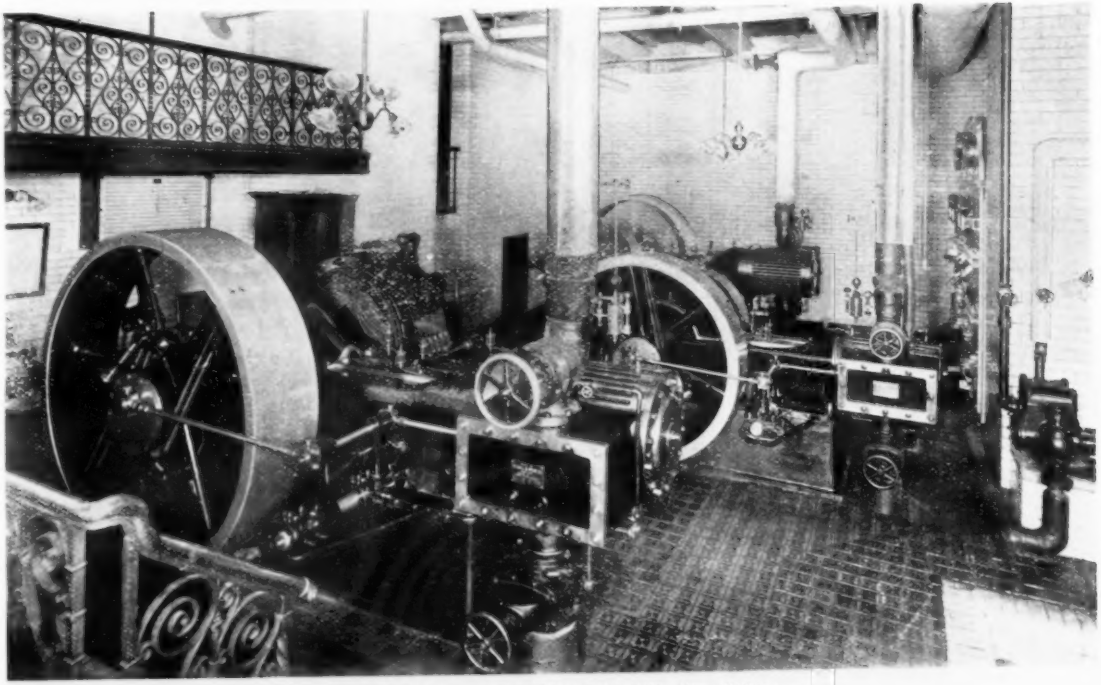
Another very handsome engine room is that of the Presbyterian Building, on the corner of Fifth avenue and Twentieth street, New York, which has lately been equipped by the Ball & Wood Company. The floor is handsomely tiled, while the walls are of white enameled brick; all the exposed piping is neatly covered with non-conducting material, and a handsome visitors' gallery occupies one side of the room, as shown in the illustration. All of the machinery is expensive and finely finished, the engines of course being carefully fitted with guards to prevent flying oil. The desire for thoroughly artistic treatment originated with the owners and architect, their theory being that the engineers could be relied upon to take much better care of the plant if every feature of the equipment were rendered sufficiently attractive to bring visitors to the gallery.

The sensitiveness of the engine trade is remarkable. Engine-rooms such as we have illustrated form but a small percentage even of those equipped during the past year: yet many drafting rooms have felt their influence, and at least two thoroughly established and well-known firms are now making radical changes to put them in line for this class of trade.

The logic of the situation seems to point to an enclosed type of engine: at any rate, if the engine is not absolutely enclosed, there must be effective protection from flying oil. Probably every engine now on the market has an oil shield affording some measure of protection, but practically all these devices have two vital defects: first, none of them affords absolute protection; second, few, if any, appear to be an integral part of the frame to which they are attached. It must be remarked, however, that no one has been so quick as the manufacturer to realize that the public is fast being educated to demand better things,—to demand symmetry for the whole and purpose in the form of each part.

As a secondary effect there seems likely to be a radical change in the system of oiling. A bath system of lubrication has long been recognized as the most perfect, and the majority of engine-builders have adhered to the old "drop by drop" method solely because the oil shields were not effective; they could not employ the method they knew to be best.

What is admissible in the amount of bright work about an engine



ENGINE-ROOM, PRESBYTERIAN BUILDING, NEW YORK.

is a more difficult point to determine; certainly the barbaric display of nickel plate, common in the past few years, cannot long withstand the refining influence of artistic surroundings. Yet a certain amount of polished work is entirely in good taste. An engine requires care, and nothing more clearly indicates that care than the gleam of polished brass and steel. This is a refinement that will come, and on all sides are the indications that there will be delicate appreciation of it on the part of the public. The more liberal patronage of the arts; the astonishing advances in architecture; the demand for artistic furnishings,—all mark the rising tide of enlightenment of the mass of the people. In architecture artistic massing of light and shade and effective treatment of roof lines find wide appreciation, and homes in every hamlet mark the popular response to the influence of a true art, to which nothing is mean, nothing lowly. In engineering structures the advance in artistic treatment has been as remarkable, although not as obvious to the non-technical public. In this advance the designer of electrical machinery has taken a leading part; with no traditions to impede the free exercise of his taste and judgment, he has had absolute freedom to follow the promptings of high ideals. The artistic treatment of electrical design was not without its influence in the field of steam engineering And thus it comes to pass that the electrical and mechanical engineer, the capitalist and the architect, have each a part in producing a harmonious whole, which cannot fail to exert a refining influence on all connected with it. The artistic engine-room is a link in a chain of influences tending to produce a higher type of manhood.

LIGHTING RESIDENCES BY ELECTRICITY.

By Augustus Noll.

IN no class of buildings is gas for illuminating purposes being displaced more rapidly by electricity than in residences. The advantages of electricity over gas are very numerous, but for the purpose of this article only a few will be discussed. When we consider that not only is the sanitation and ventilation improved, but the furnishings and decorations are also preserved, and that electricity's cleanliness, the absence of flame, heat, etc., and the color of the rays permit the use of more delicate tints and costly fabrics, to say nothing of its safety and low cost if properly installed, we need not look further for the reason of its use by the social world; as a matter of fact, in a modern residence the decorations would sometimes be impossible if gas were used for illumination, and, for similar results, the system of lighting by electricity, as now installed, could not be replaced by gas or any other known method.

The lighting of a first-class residence requires different treatment from that required in office-buildings, hotels, etc.; in the latter the location and number of lamps are fixed and their uses are well understood, while in the former the lights cannot be located by general rules, but must be treated in accordance with the existing conditions.

If the residence is of the ordinary class, the usual chandeliers and side brackets are employed; but, if the residence is of a high grade, the lighting will probably be an important factor in the decoration, and, unless it receives proper treatment, it may mar the effect intended by the artist.

Except in the library and the dining-room, chandeliers are now seldom used; they are economical, but, however artistic they may be, they generally obstruct the view and are not to be tolerated.

Where decorations are of a high grade, it would be well for the electrical engineer, even if he has had some experience in lighting, to coöperate with the artist having the work in charge, deferring to his judgment as to the location and amount of light to be used, and confining himself more particularly to the mechanical portion of the electrical work, such as control of light, appliances, etc., submitting such data to the artist.

For a well lighted room, the general tendency is to hide the lamps, unless the bulbs are used as a part of the decorations, but to so distribute them that an even diffusion of light is obtained throughout the entire space, the effect sought being that of natural light. The diffusion should be even, care being taken that shadows are not cast by the furniture, etc.

The wiring should be arranged so that lamps of greater or less candle power can be used, enabling the effects of increase and decrease of light to be noted and compared. The lamps and sockets should be interchangeable, as sometimes it is preferable to use a greater number of lamps of small candle power, so that no one portion of the room will be more brilliant than another, and also to keep the general tone of the colors forming the decorations the same throughout. Too much light is sometimes worse than not quite enough, and, in addition to its painful effect on the eyes, it gives a defective idea of color, shape, dimension, etc.

For general illumination in the principal rooms, an allowance of sixteen c. p. to each thirty or forty square feet will be satisfactory; for chambers, etc., an allowance of sixteen c. p. for every fifty square feet is usual, assuming that the height of ceilings is ordinary.

Hallway and staircase lighting depends mainly on the shape and obstructions. In general, it is better to increase the number of outlets, placing fewer lamps on each group, thereby securing a more even light, overcoming the shadows on the stairs, and obviating the danger of tripping or falling. Outlets should also be provided for stand lamps, piano and fairy lamps, and other ornamental and portable articles. These should be located in the baseboard or floor. Each mantle should be equipped with two outlets for candelabra, vases, etc.; the library, hall, and dining room should also be provided with a number of these outlets for ornamental lighting, as they are very useful for decorating tables, lighting pictures, etc. Flexible cables can be carried from these outlets to foliage, etc., interspersing the same with numerous miniature lamps of different colors, producing the most beautiful effects.

Very often the mistress of the household desires a change in the position of the furniture, or wishes to embellish a favorite nook or corner; or decorations are required for special occasions, such as receptions, balls, dinners, etc. Then these outlets will permit the indulgence of any fancy in decorative lighting, and without great expense or annoyance of workmen. It also prevents cutting of floors, wood-work, or plaster.

The principal idea should be to create and instal a system of lighting that embraces safety and permanence, together with elasticity and control,—a system in which all parts are more or less movable and accessible, the only fixed portion being the system of conduits.

Some of the most difficult problems encountered in residential lighting are the pictures and cathedral-glass windows and colored domes. In the latter the general rule is to place the lamps at a distance, thus obviating all spotty appearance. A frame of wood corre-

sponding with the frame of the dome or window can be constructed, on which to place the lamps; the number depends on the size, color, and thickness of the glass, but experience has shown that too much light is a good fault in cases of this kind, as far as the lighting effect of the dome or window is concerned. It is a very expensive decoration to maintain, on account of the immense amount of light required.

Small domes and windows can sometimes be lighted to good advantage by one reflector, provided there is sufficient space at the back. Another way would be to form a recess on the sides in the rear of the window, in which to place a reflector throwing the light across the back of the glass.

The lighting of pictures is not susceptible of treatment by any general rule, although ordinary pictures can be lighted by reflectors made especially for the purpose. The reflectors usually employed in public art galleries are altogether unsuited for residential purposes, on account of their appearance, as the art gallery in a residence generally serves also as a study or library. An effective way, if the room is not too wide, would be to locate reflectors on the ceiling about eight feet apart and midway between the side walls. They can be circular in shape and attractive in appearance. The form of the reflector is governed by the space to be lighted, and is determined by mathematical principles; to overcome the glare, the lamps are almost hidden from sight. By this method of lighting not only are the pictures satisfactorily lighted, but a fair diffusion of light is secured for general illumination of the room.

Regarding the lighting of high-grade oil paintings,—though this is generally undertaken only by specialists,—it may be of interest to explain some of the conditions which must be considered, if the lighting is to be technically correct. Usually satisfactory results are obtained only after numerous practical experiments. The amount of light needed and the form of the reflector depend upon the size, predominating color, and character of the picture, the shape and depth of the frame, and whether the picture is covered by glass.

The material and the form of the reflector must be carefully considered. Sometimes it is constructed of glass, plated with metallic silver, and, in other instances, the reflecting surface consists of soft white enamel; it is often necessary to arrange the angles of the reflector so that a strong light will be obtained. Again, if a softer light is necessary, the glass forming the reflector is made into small "facets," and fitted into the different shapes forming the various angles of the reflector.

In considering an electrical installation for a residence, the proper control of the system of lighting is very important. Switches must be

provided controlling the ceiling lights in the various rooms, and should be located at or near the entrance. Where the lighting is extensive or a great number of lights are located on the same fixture, they should be subdivided into various circuits, each circuit being controlled by a switch; while this slightly increases the first cost, the saving in light and the cost thereof more than offset this in a very short time.

In bed-chambers a switch should be located on the side wall and within easy reach of the bed, with an outlet directly above. This outlet and its control form a great accommodation in times of sickness and for reading. Switches are also located in the frames of doors in such manner that, when the door is opened, the light appears, vanishing when the door closes. Generally closets, store-rooms, etc., are fitted in this manner.

The cellar lighting is usually controlled by a switch located at the head of the cellar stairs; the servants' stairway is generally fitted with a circuit controlling all the lights upon it, with a switch on each floor. The switches are so connected that any one of them controls the lights; this is expensive, but the lights are operated only when actually required, while otherwise they would be in constant operation.

The pilot or night circuit should also be provided, keeping this circuit and system separate from the rest, arranging one light on each fixture throughout the hallways, and providing a switch at the main entrance, a switch on each floor, and a switch in the principal chamber. This circuit will be found a great accommodation in case of sickness or a visit from burglars, as well as for the belated "club man." The connections should be made so that the light can be operated from any switch. A connection can also be made from this circuit to the vestibule door and connected by switch in the frame of the door so that the opening of the door will flood the hall with light, the light being turned off from any of the remaining switches. Another connection can also be carried to the burglar alarm and arranged to operate in conjunction therewith. Thereby, the instant that the burglar alarm is thrown into operation, the halls are lighted.

The most satisfactory system of feeders for residential purposes is generally a feeder controlling all the lights on the main floors, exclusive of the pilot circuit and servants' quarters, and another controlling the pilot lighting and servants' quarters. These feeders should be carried to the cellar and connected with switches; during the absence of the family the switch controlling the main system can be broken, making it absolutely certain that the wires are "dead." Another method is to extend the main line to the owner's chamber, locating the switch therein, and thereby bringing the entire system under his control at all times.

The wire forming the circuits should be the very best obtainable; and, to secure the best results and latitude in increasing the number of lights or its candle power, a wire somewhat larger than that actually required should be installed.

The various circuits should be brought to some central point, and there connected with cut-outs, providing a cut-out for each pole of each circuit, the cut-outs to be located in a cabinet, and the cabinet lined and covered with slate to make it fire-proof. A switch should be placed between the feeder and the top circuits, so that all the circuits serving the lights on the floor may be disconnected without interfering with the lighting system on the other floors. The switches and floor outlet boxes should be of the "flush" type, the cover matching its surroundings in color, and in material if possible. Every precaution should be taken to make the cover fire and moisture proof; and the connections should be easy of access.

The system of conduits is probably the most important element in the entire work of installation. It is really the only fixed portion, and, when once placed, is usually inaccessible without resorting to excessive cutting of wood-work or plaster. To secure satisfactory results iron-armored conduits should be used throughout, as on them depend the safety and permanence of the system. Defective circuits, switches, and cut-outs can be removed without any great expense and annoyance and in a short time. These conduits withstand the blow of a hammer, and will shed nails, etc. The interior diameter should be so large that the wires will not be unduly crowded. In a proper conduit system leading lines or fish wires should be unnecessary, and, if numerous elbows are required, fish boxes can be inserted on the line at intervals. Proper precautions should be taken at all joints so that gas and water will be excluded; and where outlets terminate, either for switch or fixture, the terminals should be provided with the boxes especially adapted for the system, and all ends of conduits should be entirely closed, using some insulating material for the purpose. The conduits should be located in some definite place,—for instance, under floors in the hallways,—and should be run at right angles as far as possible, so that, in the event of any future alterations, the various lines can easily be traced.

In leaving this subject, it may be in place to mention the various other accommodations afforded in residences by the use of electricity, such as the operation of the dumb-waiter and passenger elevator, the pumping of water, the heating of plates and of foot-warmers for invalids, imitation of open-grate fire in the hearth, the ventilation of rooms, and fans for the sick chamber.

THE ARCHITECTURE OF MODERN BANK BUILDINGS.

By R. W. Gibson.

I.

AS old as civilization is commerce, and as old as commerce is banking. Its methods have undergone many modifications. Its science has been specialized in many directions. Its primitive aim—the utilization of money (or its equivalent) deposited for safe keeping—has been subdivided into numerous branches. The simple safe keeping of money is now only one department of a modern bank. Indeed, it may fairly be said that safe keeping never was banking,—that this science began only when the control and custody of funds were made productive by the utilization of the credit and power inherent in them. But this is no new science. The Romans and the Greeks, and even the Egyptians, knew the principles of interest, discount, and exchange, as methods of business already established for centuries.

The banking house and the subdivisions and furnishings of it are the machinery by which the banker carries into practice his theories and purposes. He is limited by them, just as his intellectual power is limited by his physical capacity. At the best the machinery is cumbersome. The inertia of an army of subordinates; the hampering effects of precautions against fraud; the resistance of mere time and space, which remove successive acts one from the other,—all these things impede the genius which inspires them. To reduce such obstacles is to succeed: to minimize them is to achieve brilliant success. Modern equipment places at the disposal of an executive the best allowable means of carrying out his plans.

The main features sought in a modern American bank may be summed up thus: First, facility for transaction of business with customers; involving the proper disposition of the floor spaces of a banking room for the reception of the public by the staff of the bank. Second, facility for the direction by officers, and the execution by subordinates, of the internal work; including proper relationship of

different departments to each other, the location of various rooms, cages, and departments for their coöperation, and the furnishing of all with the best facilities, in their desks, counters, screens, cases, and so on, and in the most recent time and labor-saving appliances, telephones, calls, lifts, and the like. Third, security; not only for the valuables in the custody of the bank, but also for the business confidences of which it is the recipient, and for its own records and documents, by the use of fire-proof, burglar-proof, and mob-proof appliances, vaults, safes, etc., and their accessories for police communication, and by the enduring and fire-resisting character of the whole building. Fourth, reputation and prestige; in the evidences of stability and wisdom as reflected in an artistic as well as dignified, handsome, and well-ordered building,—these things bearing upon architecture as a fine art. Fifth, comfort and convenience; including their humanitarian and economic value.

It would be idle to discuss the right to chief place in just appreciation of all these subjects; yet it cannot be doubted that their relative importance has not been altogether well weighed. Let us give a few moments to art, the least valued among them. Architecture has been too much ignored. Art, as the utterance of living sentiments, has been either banished or overwhelmed in sordid practicality. Architecture for banking has come to mean all of the aims just recited, except the fourth, which is the soul of the organization. Its inclusion here, and its basis upon sentiment, call for the first explanation, and this alone is an admission of an apologetic attitude. Yet, next after the institutions of religion and those of the State, there are none more naturally associated with monumental architecture than the corporations of finance, none which have more to offer to and to receive from architecture, the fine art, the sentiment, the silent language. All these organizations, although founded on realities, are alike sustained by sentiment. Their continued existence depends on public confidence and faith, in things which cannot be always in evidence to the senses; and this confidence is an untamed thing, with nerves sensitive to unrealities as well as to facts,—in short, susceptible to sentiment.

The churches have always recognized these arguments. What church has become great without temples, or what temples have been prized which did not place sentimental art as high as utility? Again, in government, the palace, whether royal or republican, despotic or democratic, has been always accounted good in proportion as it was artistic. All this has been for reason, and is not in error. It cannot be doubted that finance, the soul of modern industrial civilization, has a like interest in art, and with its own development will more and more recognize it.

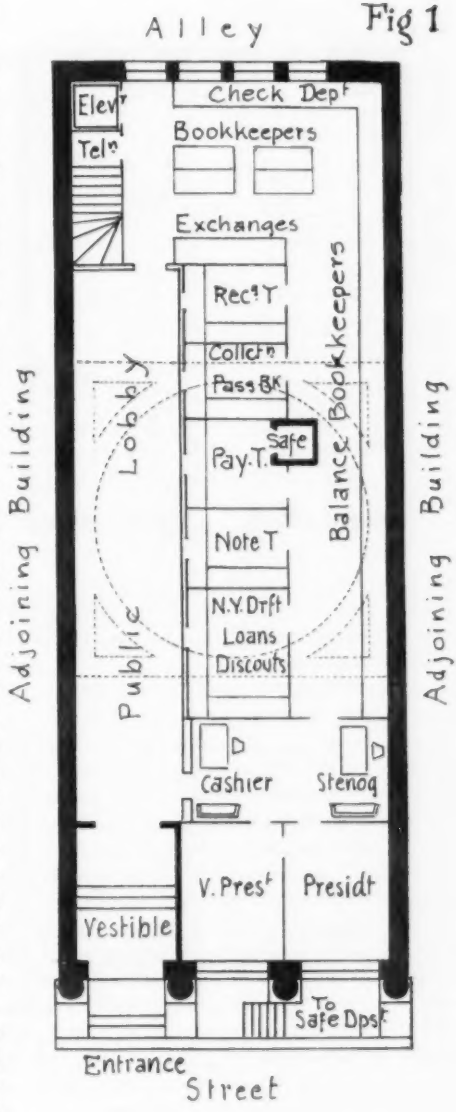
Utilitarianism, on the other hand, has been fostered to the highest degree. Consider the enlargement of power (the power to do work in a limited time) given to an executive officer, when at his desk is placed a telephone with fifteen connections to as many departments of his bank, and beyond them to its affiliations beyond its walls, whereby he can obtain the execution of an order in the time formerly necessary to transmit it. And in the same direction other electric inventions help him: the light which comes at the touch of a spring; the bell which calls attendance or help; the elevator which makes a floor above or below as accessible as the principal one; the alarm system which encases his vaults with a covering as deterrent to the robber as the fundamental steel. And so on downward to the devices used by the rank and file of the corporation: the steel cases which in the desk itself give security ready to hand, for records and documents, and save them from tedious and destructive transportation; the screens and cages which separate departments without dividing them; the counters and counter-screen which assist public communications, and from an undisciplined crowd evolve order and method; the ventilating machinery which keeps a hundred men in health where without it twenty would suffer. In all these things there is without question a progressive vitality which needs no further stimulus,—with which, indeed, it is hard to keep pace.

It is worth while to let this review take a more concrete form, and examine an imaginary modern bank from the points of view already indicated as showing the chief aims of the machine. There is available a certain space limited by extent of land or by existing walls; too often it is the latter, so we will accept that example, leaving for another place the consideration of the architectural advantages found in a separate building.

The first step in the process of specialization is to divide the space into two parts,—one for the public, the customers and their agents; the other for the staff and employees. This is not so simple a step as it may seem, for all the further subdivisions will be affected by it for good or ill. Therefore, many things must be borne in mind, and none of them allowed to unduly obscure the others. A metropolitan commercial bank with numerous country affiliations will require a large proportion of space for its bookkeepers and correspondence and check departments, and relatively less for its counter customers; while at the other end of the series a savings bank, with quarterly or other periodic dividend days, will need much more accommodation for its crowds of depositors and comparatively less for its bookkeepers. Between these extremes the bank of deposit and discount, serving a trading constituency, is likely to demand a large public department with numerous wickets for access to tellers and other clerks. For

these reasons (and not for fancied preferences) various types have appeared in the arrangement of the main counter-screen. The simple straight line dividing a public lobby on one side from a clerical department on the other—the oldest form, an example of which is shown in Fig. 1—is still the best in many cases, especially in restricted dimensions. But often, in a wider building, more counter length is needed than the available length of the room; and it is then extended in various ways. An extreme method, admirable for spacious quarters, is to double it on itself in horseshoe form; then there results an inner and outer division, the latter usually of much the larger area. For the commercial bank the public lobby will be the inner or smaller division (Fig. 2); for a savings bank the outer one will be the best, especially where the business is regulated by dividing the customers (often of the

Fig 1



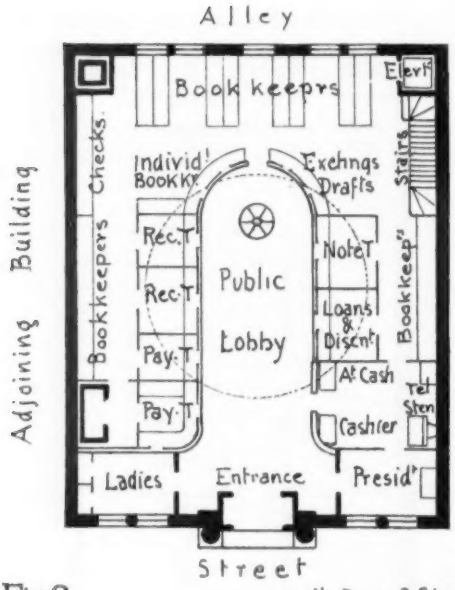


Fig 2 with Domed Skylight

poorer class) according to sex (Fig. 3). Sometimes a variation of the horseshoe plan (Fig. 4), or half of it, is better; sometimes a flattened or squared or modified form of its bend; or, in another case, a bay-like projection from a straight counter (Fig. 5). These are the usual types of plans to vary the length in its relationship to areas of floor space. The selection will be made with reference also to the utilization of the daylight,—that valuable blessing which at the street level in large cities is getting so scarce and precious,—whether it comes from front, rear, or side, or from all of these points. The tellers and bookkeepers who spend the whole day in the bank should be granted the precedence in this regard over the customers and messengers, who are each accommodated for only a brief time. If there are (and there generally must be) some places less convenient, dependent partly upon artificial light, they can be used by those who will suffer the inconvenience for the shortest time. Next to the primary division comes the appropriation of certain spaces to the chief officers of the bank, and here we come to one of the modern developments of the subject. The old-time banks, with their special charters of authorized monopoly and the consequent assurance of business, did not find it necessary to court custom, scarcely even to meet it halfway, and the private bankers, whose position was achieved without State support, were ofttimes the agents of capital timid and hesitating in the insecure justice of imperfect laws; and both conditions naturally developed officers inaccessible and unsympathetic, by reason either of the superior advantage of privilege or of the vulner-

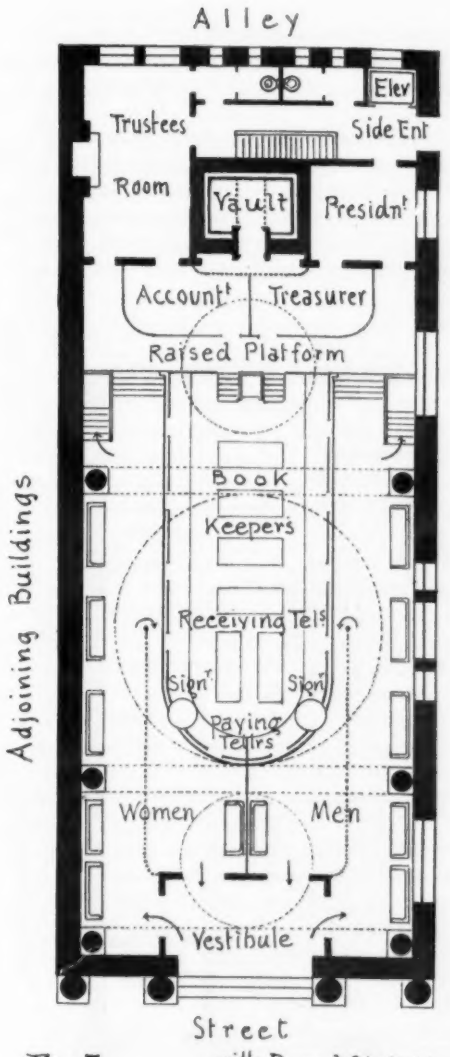


Fig 3. with Domed Skylights

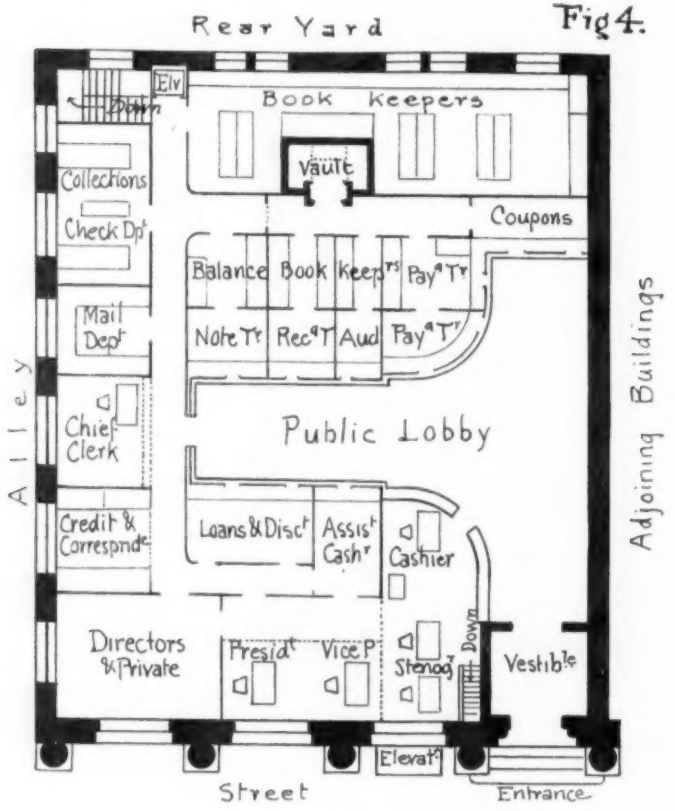
ability of weakness. In the atmosphere of industrial democracy this is so changed that the old methods of business have become obsolete.

The officers of a modern bank no longer seclude themselves in the farther chambers of a little known retreat or a fortified public building. Their departments would be half paralyzed by the slow process which fitted other times. The bank is a unit, organized to receive customers openly for immediate action. Its officers make themselves accessible, and place themselves in sympathetic contact with the world they seek to serve; and their staff is disposed so as to be quickly responsive to the master mind. Secrecy is dispelled by increased confidence in law and order. The guards and bars are erected against only the criminal classes, and are no longer needed to awe the community or resist its government.

The practical result of all this is that the officers' rooms of a modern bank are the first departments encountered upon entering it. They are separated only by low railings or parapets from the lobby, and visitors enter at will through a gate which has usually not even a latch.

Their proximity to the entrance and to the street carries with it the advantage of front windows and good light. There are still some cases in which the officers' rooms may be better arranged at the rear of the building, as in Fig. 3, which shows a plan for a savings bank demanding large spaces for crowds of depositors who do not need to see the officers and who can, therefore, be attended near the entrance and exit.

Fig 4.



From the chief officers the administrative work is transmitted to subordinate officers, who are consequently to be next considered and stationed conveniently near, and thence to various departments with more or less need of communication. Now, it is clear that the president or cashier desires *all* his departments accessible, but it is equally clear that some must be more remote than others. The question is which can best occupy the more remote places that have to be utilized somehow. This brings us to the problem of planning for internal facility. A large institution makes special allotments of space for the following departments: loans and discounts, credit and correspondence, mail, notes, auditor and passbooks, receiving teller, paying teller and safe, exchanges and collections, checks, bookkeepers, vouchers, and a few others of special nature, which may be grouped with one of the above. Often two or more of these offices are combined in one with advantage. In most banks the tellers are reponsible persons, whose work is systematic, and who can act without frequent special direction, while the loan and discount department is subject to continual special instructions, and must be in charge of the assistant cashier or other manager accessible to the chief. The loan department, therefore, is placed near the officers' rooms. The money department may generally be more remote, although it must, of course, be at the counter-front. So must the passbook department, which is frequently now made the office of the auditor, who, in recent systems of book-keeping, reviews and compares the work of the various subdivisions. This and the coupon and exchange departments are naturally associated with the cash tellers. The note teller is usually near the loan and discount division; see Figs. 2 and 4. Beside these, all of which need to be accessible to the public at the counter front, there have to be many bookkeepers stationed conveniently near and to the rear of them, so that the transactions of the counter may be entered in the ledgers without undue transportation of preliminary records. And, lastly, there must be spaces for those clerical departments needing no access to the public, including, near the executive, credit and correspondence, stenographers' and mail departments, and, more remote, the check desks, the collection department, the voucher clerks and files, stationery stores, telephones, &c. Sometimes the clerical force in this last group is placed in charge of a chief clerk, who is so placed as to command the entrance and receive messengers and others.

These arrangements represent, it will be seen, a very large bank,—a New York commercial bank, as we noted at the outset, and one, moreover, which does a large correspondence with country bankers. The plan shown in Fig. 4 is a good example; it is based upon the

newly-constructed banking room of the Chase National Bank, New York city. For reasons which will be self-evident, it is not a plan of the Chase Bank, but only of a similar bank in somewhat similar quarters. It is also apparent that some of the special features of this plan would be unsuited to another bank. Here the practice of subdivision and isolation of departments is carried out according to the most recently advanced ideas. The great floor is spaced out, and each group is fenced or caged in with brass and steel open work with locked doors and rigid rules. Each room or cage has its telephone and "buzzer" (the electric call used in place of bell) from the executive, and "hand passes" or wickets for the transmission of papers, etc., so that there is little need for any man to leave his place. It will be noted that the daylight available, as shown on this plan, is better than usual in a New York bank: this is assumed, in order to make a less complicated problem. The absence of the rear windows or the side windows would require radical changes in the plan, unless top lights were available. Nothing can be better for a banking room than a domed ceiling with a large central skylight, and, though the financial conditions which prevail in New York city make it seldom attainable, except by savings banks, yet, in places where real estate is not so expensive and so unavailable, there can be no better service rendered to a great bank than to give it a building with lofty proportions and a top light. Another point developed on this plan is the single entrance. To secure full supervision and safety, a good modern rule insists upon only one entrance to a bank (however large) from the exterior, and only one gate to the clerical department. Outside access to the basement may have to be arranged for a caterer or engineer, but even this should, if possible, be combined with the main entrance vestibule, or else made an elevator controllable by only one person. If there must be a rear or side door, it should be so planned as to be easily supervised, and should not lead directly to vaults or clerical rooms, but into engineers' rooms or locker rooms, dining rooms, or the like, and thence to the working places. Not only the ubiquitous sneak thieves, but the more ambitious robbers whose methods are a daytime surprise or a midnight burglary, are discouraged by a system which deprives them of the opportunity to make preliminary observations without attracting suspicion.

The plan shown in Fig. 2 is another form of a commercial bank. It is based upon the building lately erected for the Bank of Buffalo, and drawn so as to show the principles involved without actually publishing its arrangements. The horseshoe form of counter gives a long front affording numerous wickets. The departments are planned, as will be seen, on the same principles as in the other scheme, but with

less subdivision. There is also a ladies' room, which is a feature not infrequent nowadays, when women show growing appreciation of the conveniences of a check book. This building has the advantage of a glazed dome, in addition to good window light. It has a gallery, accommodating the correspondence department; an upper story with directors' and other rooms; a basement with vaults and clerks' rooms, dining rooms, etc.: and some spare space.

Fig 5.

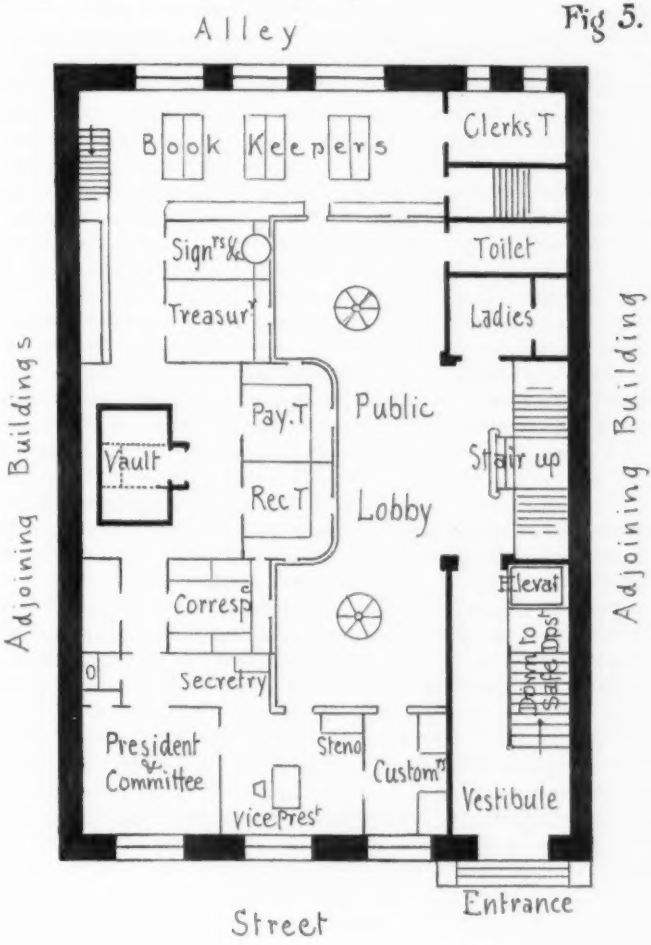


Fig. 1 shows a plan suitable for many busy banks in buildings of limited width and having only front and rear light; the same principles prevail, and need no further explanation than the names of departments upon the plan. This also illustrates the circumstances of an actual bank, although the plan is varied in certain respects.

Special and less regular arrangements are required by trust companies. The plan shown in Fig. 5 is an adaptation of that of the Rhode Island Hospital Trust Company, which does a large banking business at Providence. There is sometimes in a trust company's office less of the bank character than is here indicated. The officers are known by different names, and the business is with less hurried and less numerous customers. Sometimes, as in the United States Trust Company in New York, the counter screen can be dispensed with, and nearly all cages omitted with advantage. In fact, it is not possible to establish a type for these offices. The instance illustrated (Fig. 5) is of a building which has several rooms in stories above and a safe-deposit department in the basement; hence the need of two or three staircases. Daylight is obtained from a top skylight as well as from front and rear windows.

The savings bank plan, shown in Fig. 3, is a condensed adaptation of the Greenwich Savings Bank, New York. This is a good example of a class entirely different from those already described. The numerous depositors have to be marshalled by guiding rails leading them from the entrance lobby to the receiving teller or to the pass-book and signature clerks, and thence, for withdrawals, to the paying teller and the exit, by doors separate from the entrance. The public lobby of a savings bank must be liberal in size, and, therefore, the outer division of a horseshoe plan of counter-front is often devoted to that purpose. This also facilitates a useful seperation of the two sexes, grouped on both sides of a central tellers' department.

The bookkeepers occupy the middle space. The loan department is practically the offices of the treasurer and president, where the quieter business, usually in negotiations for large sums borrowed on mortgages, requires accommodation entirely different from that afforded by the loan offices of a commercial bank.

These five examples are types of floor arrangement upon which modifications for local details are engrafted to suit nearly all the modern requirements.

The details of other parts of the buildings—the vaults and clerks' accommodations, storage, and so on—and the consideration of the constructive and artistic elements of the building itself will be treated in a future paper.

PROSPECTING WITH THE DIAMOND DRILL.

By J. Parke Channing.

WHILE the diamond drill is principally used to determine the character of the ground passed through, such is not always the case. Holes may be put down from the surface to strike water, brine, gas, or oil; to afford access to a mine for steam pipes, air pipes, or electric wires; or to conduct water to fires in the workings. Holes started underground may be drilled for ordinary charging and blasting with powder; to tap the water from adjoining workings on the same or a higher level; to afford a passage for pipes or wires; or to act as pilots, in case the workings are approaching any place from which an outburst of water or gas is expected. In the Lake Superior district the usual size for holes up to 500 ft. in depth is about 1½ in. removing a core 1 in. in diameter. The next size is a 1¾-in. hole with a 1¼-in. core, and for very deep holes a 3-in. hole with a 2-in. core. For special purposes holes have been drilled as much as 16 in. in diameter, with correspondingly large cores.

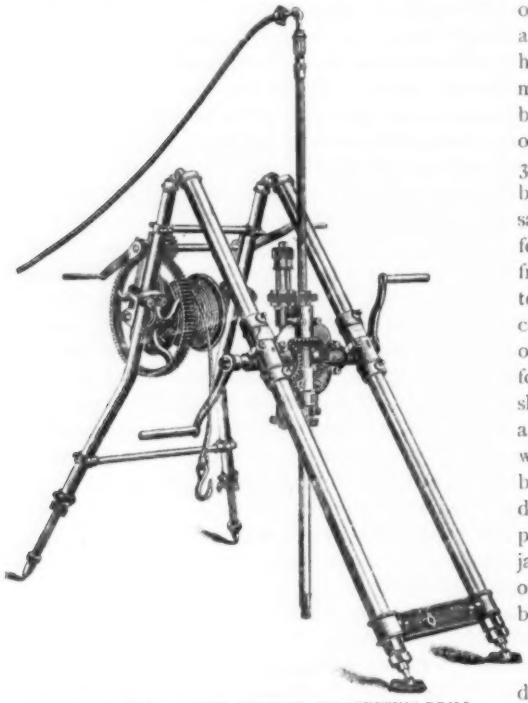
From the following notes on diamond-drilling a detailed description of the machinery and accessories is omitted, since they are familiar to engineers and others who have had experience in this line of work, while published descriptions are readily accessible to all who may wish to inform themselves as to these details. Only such points will be here considered as, it is thought, may prove useful in practice.

There is not much difference in the practice of underground drilling as compared with "shanty" or surface drilling. In underground work one drills flat and upwardly-inclined holes as well as vertical and downwardly-inclined holes; the latter, however, are the only holes drilled from a shanty. Underground the back or roof of the level or stope furnishes a place for attachment of the hoisting sheave, a pipe from the pump column the water, and a hose from the compressed-air pipe the necessary power. Surface drilling is generally done in places remote from water or air under pressure, and requires a complete outfit. As a rule, the rock surface is covered with earth or glacial drift (a material entirely unsuited for diamond drilling), which must be penetrated and held back till the solid rock is reached. If the surface is light, or if it is desired to drill many radiating holes from a single point, a pit or shaft is sunk.

This may be a simple pit, with nothing but a little curbing of light plank to prevent its caving, or it may be a fair-sized exploring shaft work with steam hoist and steam pump. If the loose surface is

deep,—say, over 15 or 20 ft.,—or, if the natural water level is high, it is necessary to drive down a standpipe to the rock, through which the drill rods may be introduced. A loose sandy or gravelly soil is best for driving pipe. Boulders retard the progress of the pipe, and often entirely block its progress, so that several attempts in approximately the same position must be made to get the pipe down to ledge.

This driving of standpipes is one of the most indeterminate items in the cost of diamond-drill work, so much depends on the character of the ground. With a drill-runner, a helper, and a fireman, and a boiler burning half a cord of wood a day, a 35-ft. standpipe can be put down, in sand and clay with few boulders, in from two and a half to three shifts, at a cost of not much over 50 cents per foot. It took six shifts to put down a standpipe 37′ 4″, where the first pipe broke when 31′ 9″ down, from which point blasting in jasper, loose ledge, or boulders had to be resorted to. As an extreme case, a standpipe was driven 96 feet through coarse gravel with many boulders in two months, working night and day. This was a total of one hundred shifts. The pipes broke twice, and had to be pulled out and re-driven. Many boulders were drilled and blasted. The total cost was approximately $7 per foot. This was an exceptionally hard hole, and shows what one may encounter. On the contrary, standpipes have been put down in swamps 50 and 60 ft. in a few hours.



SULLIVAN HAND-POWER DIAMOND PROSPECTING DRILL.
Capacity 300 ft.; Hole 1½″; Core 1$\frac{5}{16}$″.

SINKING A STANDPIPE BY THE USE OF A PORTABLE HOIST.
Photographed by Geo. Gibbs, M. E. of the C. M. & St. P. Ry. Co.

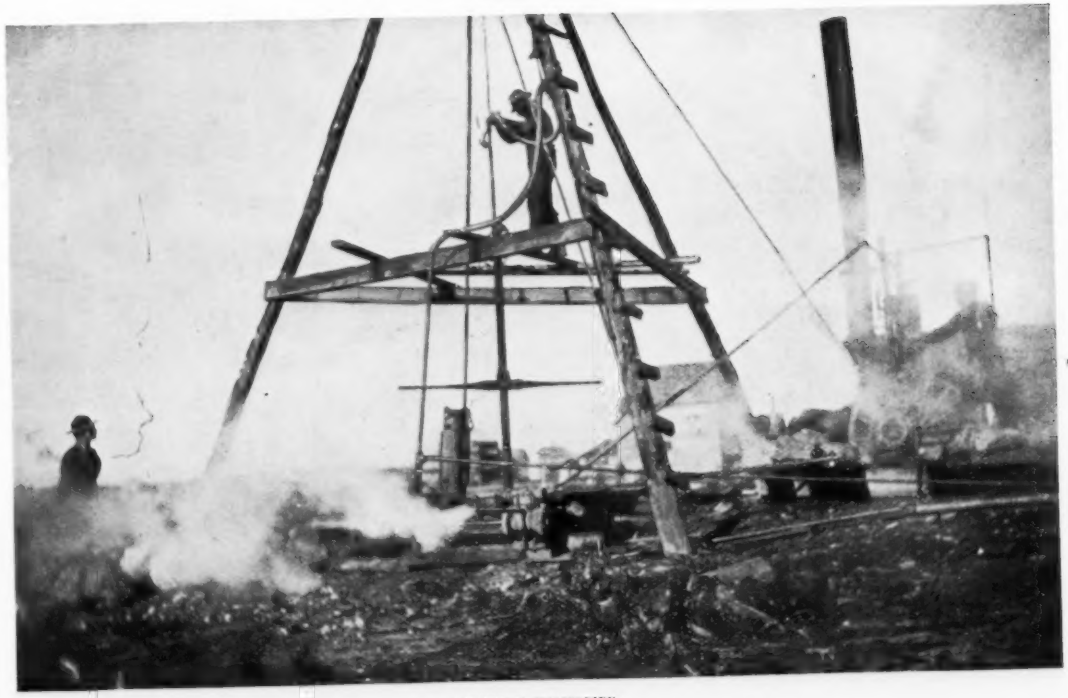
the only difficulty being with the layer of boulders on top of the ledge.

Having driven a standpipe to the ledge, and cut off the sand from coming in by drilling a casing into the solid rock a few inches, the drilling proper begins.

It is at this point that conditions are most favorable for the drilling. The hole is clean and, the character of the rock being known, the drill runner has set his drill for the correct feed. The drill is given enough steam to keep it up to the regular speed, which would be about 200 rev. per min. The speed of the pump is so regulated that the cuttings are washed up through the casing without clogging ; a velocity of 12 in. per second will assure this. If everything continues favorable, the drill may run till the core barrel is filled. The guides which the drill runner has are the speed of the drill and the flow of the wash water. If the bit encounters harder rock, the resistance will be greater and the drill will slow up, and *vice versa*.

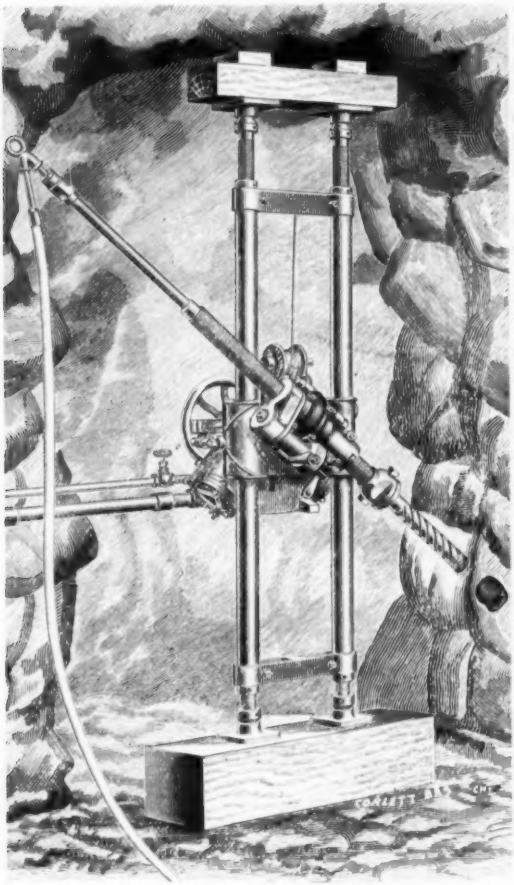
If perhaps, as is constantly occurring except in the massive rocks, the core, because of slips, seams, and alternation of hard and soft material, becomes clogged in the bit, the core shell, or the barrel, there will also be a retardation of the speed of the drill because of the extra energy consumed in grinding away the core. This effect may be differentiated from a change of ground by noting the overflow water. The passage in the bit being clogged, the overflow will be diminished, and the pump will slow down and labor. In the latter case it will be necessary to pull the rods, uncouple the bit and core shell from the barrel, and, with a few smart blows of a hammer, dislodge the core.

If, after the hole is down some distance, it has passed through a layer of porous or broken ground, it may happen that the water is "lost,"—that is, has gone down through the rods and returned up the hole to the broken zone, where it becomes dissipated, little or none reaching the top of the hole or surface. In such cases the drill runner must have a pressure gage on his pump to inform him when the bit becomes blocked. Lost water is not very desirable, and many devices are resorted to in order to fill up the cracks. Among these are the sending down of liquid cement or of material like bran. In boring in certain hard rocks it occasionally happens that a piece of core is divided by a slip making an acute angle ; the two wedges slip by each other, binding the core tightly, and yet not cutting off the flow of water. In cases like this the runner must take into consideration the condition of his bit. If his experience shows that a bit should cut 5 ft. in the rock before it becomes dull, and this slowing up of the drill happens after only 2 ft. have been drilled, the presumption is that some core has become wedged. A temporary blocking will often give



SINKING STANDPIPE.

Photographed by Geo. Gibbs, M. E. of the C. M. & St. P. Ry. Co.

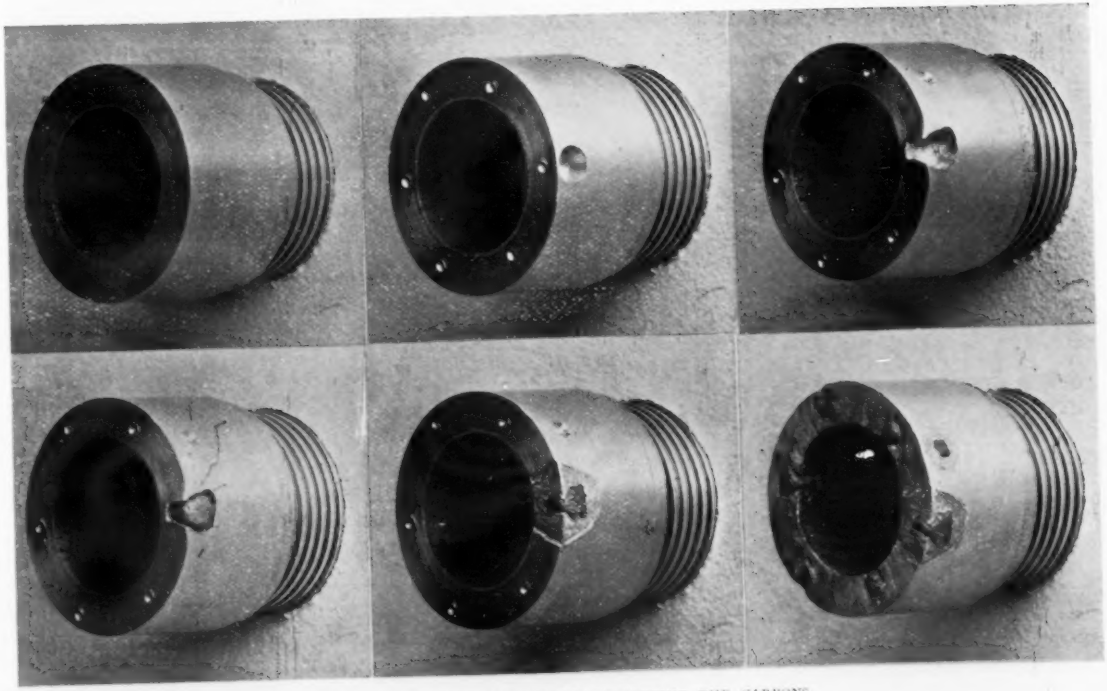


BULLOCK DIAMOND DRILL UNDERGROUND SET FOR A 45° DOWNWARD HOLE.

way after further drilling, but the runner must learn by experience in different kinds of ground what to expect.

If a rod were to twist off in drilling, the drill would speed up, and the water, having a freer course, would allow the pump to increase in speed and discharge. If, when the rods are hanging from the machine and the bit is off the bottom of the hole, the rods rotate with difficulty and in a jerky manner, it is an indication that some foreign material, such as sand, gravel, or fragments from the side of the hole have got in between the rods and the hole.

The runner should note the depth of the hole, when changes in speed occur which may indicate change of ground; also changes in the appearance of the wash water, remembering that a certain time elapses, after a change of ground is encountered, before the cuttings come up. Foreign material, such as drops of candle grease, is often run through the rods to give a rough idea of how long it takes the wash water to make the circuit from swivel to overflow pipe. The

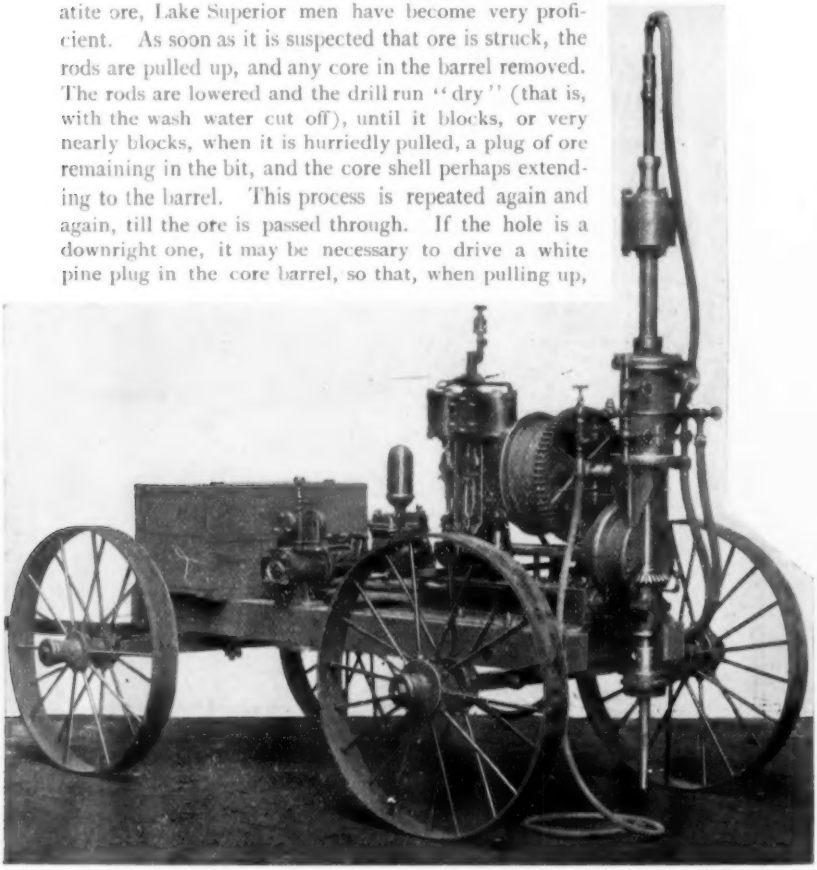


VIEWS OF BIT IN VARIOUS STAGES OF SETTING THE CARBONS.

1. Blank bit.
2. Bit marked and one hole drilled.
3. Hole enlarged by chiselling.
4. Carbon placed in the hole.
5. Carbon caulked in place.
6. Finished bit showing six regular stones and one of the two clearance stones.

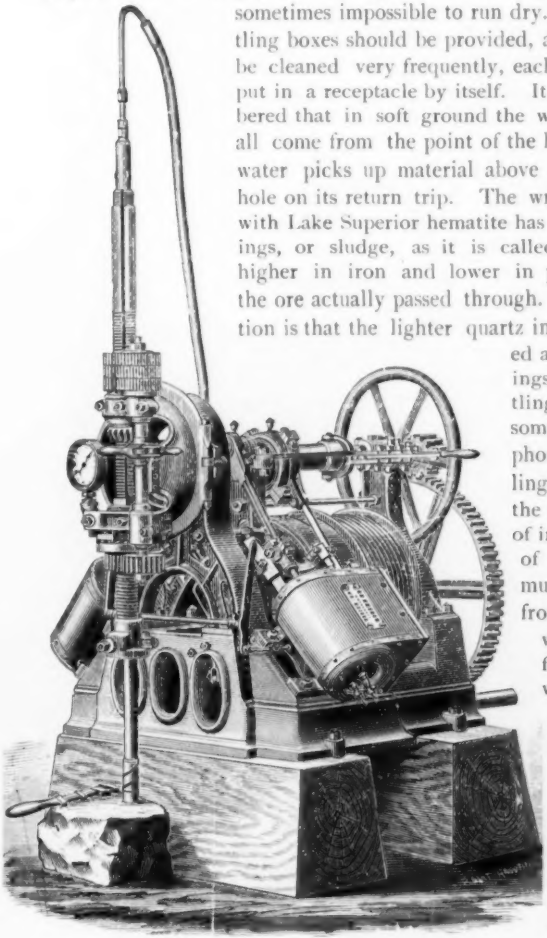
Though the courtesy of Messrs. Olaf Hallgren Setter, and W. H. Johnston, Supt. Lake Superior Mine.

reason that it is necessary to take these precautions is that, if 10 ft. of ground is drilled, the total core secured may be only half that length; nor will the pieces be proportional to the length of each kind of material. The harder pieces of core will wear away the softer, and remain more in evidence. The prevailing idea is that soft material cannot be made to furnish a satisfactory core. This is a mistake; double core barrels (in which the wash water passes down through the annular space) are made, and also core lifters that do not come in contact with the core till the rods are pulled. In drilling in soft hematite ore, Lake Superior men have become very proficient. As soon as it is suspected that ore is struck, the rods are pulled up, and any core in the barrel removed. The rods are lowered and the drill run "dry" (that is, with the wash water cut off), until it blocks, or very nearly blocks, when it is hurriedly pulled, a plug of ore remaining in the bit, and the core shell perhaps extending to the barrel. This process is repeated again and again, till the ore is passed through. If the hole is a downright one, it may be necessary to drive a white pine plug in the core barrel, so that, when pulling up,



A PORTABLE DIAMOND DRILL (SULLIVAN) FOR SURFACE WORK.

the column of water in the rods will not force out the plug of ore. This process is slow, but gives one an accurate record of the ore. It cannot be impressed too strongly upon drill-runners that accuracy must never be sacrificed to speed. In soft ground great attention must be paid to the cuttings, as in an ore with hard and soft parts it is sometimes impossible to run dry. A series of settling boxes should be provided, and these should be cleaned very frequently, each cleaning being put in a receptacle by itself. It must be remembered that in soft ground the washings will not all come from the point of the hole. The wash water picks up material above the point of the hole on its return trip. The writer's experience with Lake Superior hematite has been that drillings, or sludge, as it is called, are generally higher in iron and lower in phosphorus than the ore actually passed through. The presumption is that the lighter quartz in the ore is washed away in the tailings from the settling boxes, as also some of the phosphorus. In sampling hematite sludge the metallic particles of iron from the wear of the rods and bit must be removed from the powder with a magnet before the chemist weighs out the charge for analysis.

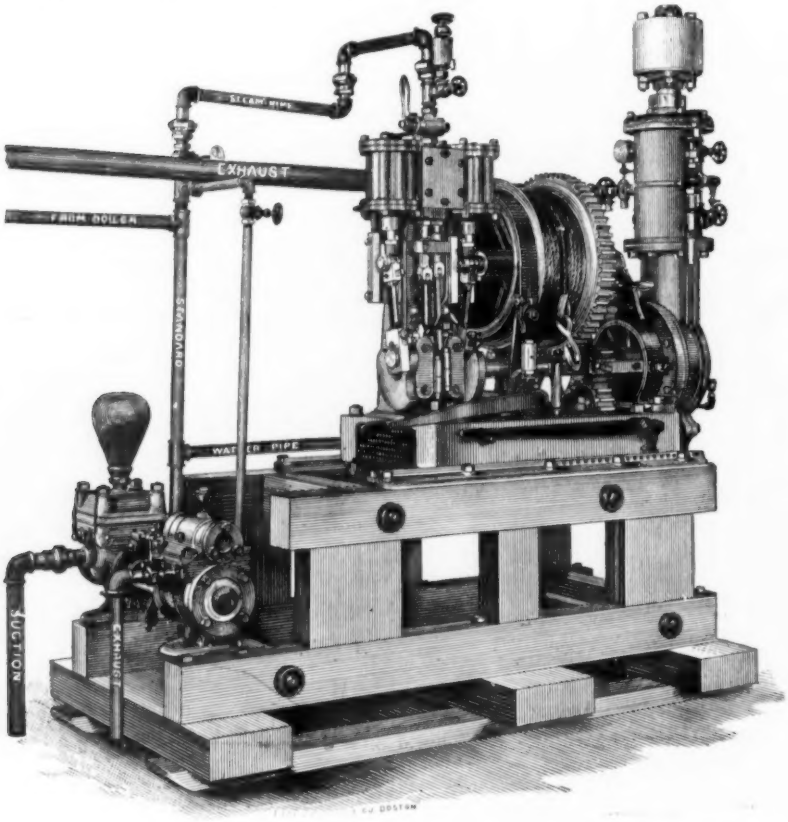


BULLOCK DEEP-HOLE DIAMOND DRILL.
Capacity 2500 ft.; core $1\frac{7}{16}$".

A good runner should constantly have his two-foot rule at hand, and know accurately the depth of the hole when he stops drilling. He

must be sure that, before starting to drill again, the bit is down on the bottom of the hole, and not resting on a piece of loose core or a caved-in piece of rock. Nothing cuts up a bit like a piece of loose rock swirling around like a cannon ball in a pulverizer. Careless running in broken ground and trying to "tong" a bit down a hole that is too small for it are liable to break diamonds. The hole also must be kept to gage.

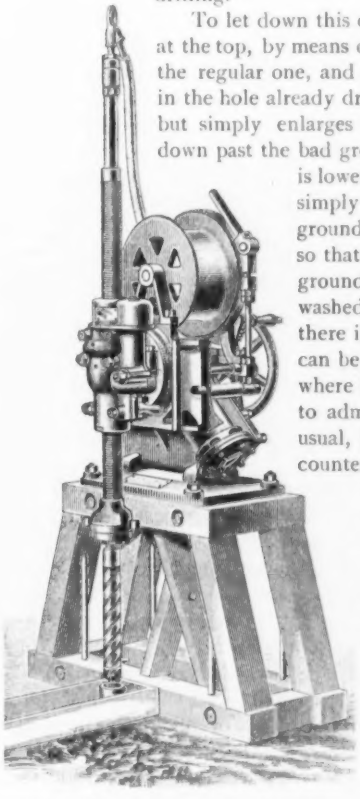
As holes become deeper, the time spent in lowering and hoisting increases. For example, in a certain hole at an angle of 45°, when 310 ft. deep, it took 15 min. to lower and 25 min. to hoist; when the



SULLIVAN DIAMOND DRILL MOUNTED ON FRAME, WITH HYDRAULIC FEED AND DRUM.

hole was down 531 ft., it took 30 min. to lower the rods and 45 to hoist. This was at the bottom of a pit, and only 10 ft. of rods could be handled at a time. On very deep holes it is advisable to build a tower, like those used in oil-well drilling, so that the rods can be uncoupled in long lengths.

If, after going through hard formation, a soft, caving ground is struck, it often becomes necessary to shut off this soft ground with a pipe called a casing. This is simply a strong pipe, threaded inside at one end and outside at the other, so as to make flush joints. It is of sufficient internal diameter to permit the passage of the regular bit used in drilling.



BULLOCK DIAMOND DRILL FOR SURFACE PROSPECTING.

To let down this casing, the hole is enlarged, beginning at the top, by means of a reamer. This is a bit larger than the regular one, and provided with a guide in front fitting in the hole already drilled. The reamer produces no core, but simply enlarges the hole. The reaming is continued down past the bad ground, and, when completed, the casing is lowered. It is seldom that this casing can simply be lowered down, except in solid ground. It is usual to put a bit upon its end, so that it can be drilled down through bad ground. Its core, if any, is chopped up and washed out. On the European continent there is in use an expanding reamer, which can be sent down inside a casing past its end, where it will ream out a hole of sufficient size to admit the casing. In this country it is usual, if a second run of bad ground is encountered, to send down a second smaller casing, or else withdraw the one already in, while the hole is reamed to a greater depth.

The mishaps that may occur in drilling are many. The most common is the parting of the rods while in the hole. This may come from a fracture of the rods, the stripping of a thread, or the unscrewing of a coupling. The last is more liable to occur when pulling the rods than at any other time, and may result in smashing a set of stones. If rods are simply uncoupled, they can usually be caught by gently

lowering and entering the top piece, and turning it to the right. In cases of fractures various sizes of inside and outside recovery taps are provided. The writer once spent two days in recovering a bit in a flat hole where the core shell had twisted off at the core lifter ring and left the ring in the lower half of the shell. The recovery tap entered the ring, which was so hard that the tap would not catch it, and yet it would twirl around with the tap, preventing the tap from advancing and catching the inside of the shell. After cutting several portions from the end of the tap, it finally caught the top of the broken shell with one thread and pulled it out.

When casing or rods are fast in a hole near the bottom, that portion above the obstruction can be removed with a left-hand tap. In using left-handed taps the right-handed rods must be pinned at their joints to prevent unscrewing. Fishing for broken rods is much complicated in cases where the ground is soft or caving and large chambers have been washed out in which the end of the rod may rest and the tap pass by it. It sometimes happens that a diamond is wrenched loose from its setting and remains at the bottom of the hole, either unbroken or in several fragments, when the rods are withdrawn. In cases of this kind the bottom of the hole should be cleaned out by a mass of soap or wax attached to the end of the rods and lowered in the hole. The fragments of rock and carbon will adhere to the sticky material, when it is withdrawn. If caving ground catches the rods above the bit, they may be released by drilling down a casing outside of the rods and cutting away the bound rod with a steel rose bit.

Overcoming difficulties at the bottom of a deep hole will tax the ingenuity of a good runner and show his capacity. No man should undertake a deep hole—one over 750 ft.—who has not had a good experience with shallow holes.

In prospecting for ore the value of a diamond-drill hole does not depend upon the fact that so many feet have been drilled, but upon an accurate knowledge of the strata passed through. To this end the cores should be carefully saved and put away in racks for reference. In drilling through long distances of the same barren material, it is not advisable to retain all the core; only a proportionate part need be retained. The racks are flat boxes, generally a foot wide, six to ten feet long, and one to two inches high, according to the size of the core. The interior is divided by thin longitudinal strips into spaces as wide as the core is thick. Little square blocks of wood should be inserted from time to time in the spaces between the pieces of core on which the depth of the hole at that point is marked. In addition to this, the head drill runner should keep a note-book, in which he records changes of ground and all items of interest. In mine work

blanks are often provided, on which the runner makes daily reports of his work to the office.

The engineer in charge of the work should locate the collar or top of the hole with reference to some permanent mark, giving the course and the angle from the horizon at which it was started.

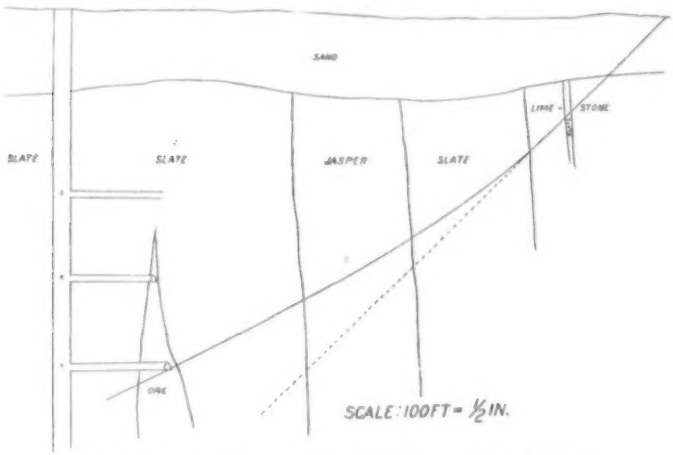
It has generally been supposed that drill holes continue on the course upon which they were started. This is not so. The divergence will depend upon the nature of the ground and the condition of the

PROFILE SHOWING CURVATURE OF HOLES SURVEYED BY J. PARKE CHANNING.

boring tools. If the hole is laid out vertically, it is liable to take a spiral course, or perhaps run off in one direction. At one of the Cliffs Shafts in Ishpeming, Mich., a vertically-started hole at a depth of about 400 ft. was some 15 or 20 ft. out of plumb. Mr. C. Le Neve Foster notes two marked cases. At the Scotchman's United mine, Victoria, a diamond drill-hole 370 ft. deep was deflected 37 ft. 3 in. At the Oriental Company's mine a hole 425 ft. deep was 60 ft. 9 in. out of

its proper course. Hughes mentions a hole at Dienslaken that varied 47° at a depth of 750 ft. A hole at Leith in Holstein, went spirally and at a depth of 984 ft., varied 3° from the vertical.

In a similar manner inclined or flat holes will vary. In 1893 the writer tested nine holes which he had drilled in Michigan. These holes were laid out at angles varying from 15° to 60° from the horizontal, and the variations at the bottom were from 11½° to 42°. It was invariably found that this variation was in the line of flattening. A hole started at an an angle of 45°, when down 353 ft. had flattened to an angle of 3° from the horizontal, and another, started at 60°, had, at a depth of 576 ft., flattened to 18°. Capt. Peter Pascoe of

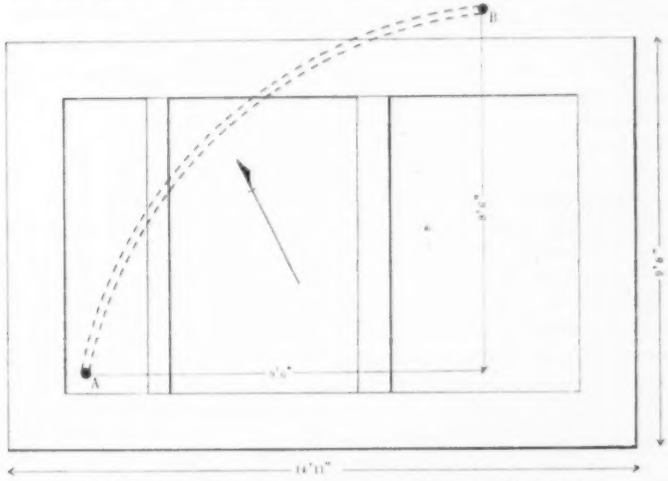


CHAPIN MINE, CROSS SECTION THROUGH "D" SHAFT AND DRILL HOLE.

the Republic iron mine, Michigan, reported that in his mine "horizontal holes invariably raised as they gained in length."

At the Chapin mine, Iron Mountain, Michigan, a drill hole north of the present "D" shaft was put down at an angle of 45° pointing south. It struck ore at about 725 feet., or what should be the eighth level of the mine. After the shaft had been sunk and the drifts run out, the hole was encountered on the seventh level, 96 ft. higher up and 70 ft. further south than the supposed position. This flattening is due to the flexibility and weight of the drill rods and their smaller cross-section as compared with that of the bit. The rods and core barrel lie on the lower side of the hole, while the bit fills the end. This causes the line of boring at any period to make an angle with the axis of the hole in which the tool is rotating, thus making the

line of advance an upward curve. It has been found that, when the clearance on the bit is a minimum and the core shell and the core barrel are renewed as their wear becomes noticeable, the holes keep much straighter. Calculations show that in some cases the whole of the difference in diameter between the bit and the core barrel produces its effect in less than 20 in. back of the bit. The writer suggests that, in case it is desirable to keep this curvature at a minimum, a bushing set with carbon and of the same gage as the bit be used between the core shell and the barrel. The influence which alternation of hard and soft material has upon the deflection of a hole has not been positively determined. Claims are made that the hole will



PLAN OF NO. 1 SHAFT, HAMILTON ORE CO., IRON MOUNTAIN, MICH.

A. Location of drill hole at surface. B. Place where hole disappeared, 490 feet below surface. Dotted lines show course of hole for the 490 feet.

have a tendency to run parallel to the formation, and equally strong are the claims that it tends to assume a position at right angles. In very soft caving ground, such as hematite ore, the hole is liable to drop down, instead of curving up. This is due to the washing away of the material on all sides of the actually-drilled hole. Most drill runners are very indignant, if it is suggested that drill holes do not run staight, but the fact nevertheless remains. If a few hundred feet of rods are laid out on the ground in curves, it will be seen how flexible they are, and how easily rotated, in that position. If this curvature is determined and allowed for, the results of drilling will be greatly increased in value.

In 1880 G. Nolten of Dortmund, Germany, proposed the use of glass tubes containing hydrofluoric acid. These were lowered down the hole and left until the acid had etched a ring on the sides of the glass. On withdrawing the tube and holding it so that the top of the liquid coincided with the etched line, it would be held at the same angle as when in the hole. This was the method employed by the writer in Michigan.

In 1883 E. F. Macgeorge, an Australian engineer, invented and used tubes filled with gelatine, in which delicate glass plummets and small magnetic needles were suspended. These were heated to a temperature of 180° F., which liquefied the gelatine. They were inserted in the hole at various points, and left in until the gelatine solidified. On being removed from the hole, the angles made by the plummet and the compass with the axis of the tube were measured, and the results plotted on the map. In those districts where magnetic material in the rocks deflect the needles irregularly, the compass cannot be used. This would be the case in most of the Lake Superior district and in all the New Jersey magnetite mines. Nevertheless, in important holes the measurement of the vertical angles alone will be of great value.

It is on the continent that the deepest drill holes have been put down. The hole at Paruschowitz in the district of Rebnik, West Silesia, was started with a bore of 11.8 in., and, at a depth of 6,568 ft., had been contracted to 2.8 in. It is proposed to put this hole down 8,000 ft. At Schladenbach a hole was put down by the Prussian government in search of coal, mostly through sandstone. It was begun in June, 1880, and, after a year's work, abandoned till the end of 1882. In January, 1885, it had reached a depth of 4,600 ft., and the cost up to that point was about $25,000.

In South Africa, on the Witwatersrand, the Simmer & Jack Company put down a hole which struck the main reef at 2,391 ft. This was one of the most important holes on the Rand, and showed a reef 9 ft. thick, assaying 1 oz. 15 dwts. of gold.

The Minnesota Iron Co. drilled a hole at Soudan, Minn., which was 2,208 ft. deep. The deepest incline hole on Lake Superior was probably one in the Lake Superior mine at Ishpeming, about 1,000 feet, at an angle of 30°.

Improved machinery and experience in drilling have tended to the use of smaller holes, which, of course, are much cheaper than those of larger diameter. In holes not more than 750 ft. deep it is much cheaper and speedier not to use a bit over 1½ inches in external diameter. For coal or friable material this rule would not apply.

The tabular cost statements which accompany this article are self-explanatory.

RECORDS OF COST IN DIAMOND DRILLING.

TABLE I.

	5 Holes 1066 Feet Sandstone & Hematite		1 Hole 1293 Feet Black Slate & Jasper		3 Holes 478 Feet Jasper, Taconyte & Hard		5 Holes 780 Feet Jasper & Hard		1 Hole 216 Feet Iron Slates		1 Hole 174 Feet Jasper & Slate		2 Holes 247 Feet Jasper		1 Hole 410 Feet Jasper		Total 21 Holes 4668 Ft	
	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.
Labor	753 38	707	1344 70	1040	1167 70	2.443	897 38	1150	125 58	.581	281 00	1.615	235 00	1.030	705 00	1.720	5569 74	1.189
Fuel at Boiler	99 90	.094	349 05	.270	122 50	.256	15 00	.019	0 00	.000	37 00	.216	24 00	.090	87 92	.214	735 97	.157
Camp Account	397 96	.373	723 04	.559	376 96	.789	419 37	.538	63 66	.295	108 00	.621	102 50	.384	225 00	.549	2416 49	.516
Bits & Ream on Drills	147 93	.139	142 47	.110	140 55	.294	133 54	.171	29 25	.135	25 00	.144	27 50	.103	76 00	.185	722 24	.154
Steffler's Coke & Fuel for Ream	36 55	.034	84 07	.065	18 54	.039	57 52	.074	5 00	.023	5 60	.032	3 00	.011	16 80	.039	226 29	.048
Carbons	280 11	.263	851 40	.658	410 25	.859	671 03	.860	182 01	.843	276 29	1.587	249 40	.934	280 50	.684	3201 09	.684
Superintendence	255 00	.239	416 13	.322	300 00	.628	31 06	.040	13 47	.063	33 33	.192	37 50	.140	125 00	.305	1211 51	.259
Total	$ 1970 83	$ 1.847	$ 3910 86	$ 3.024	$ 2556 00	$ 5.345	$ 2224 90	$ 2.852	$ 418 99	$ 1.940	$ 766 82	$ 4.401	$ 718 90	$ 2.692	$ 1515 42	$ 3.696	$ 14083 32	$ 3.007

E. J. Longyear, Hibbing, Minn.

TABLE II.

	A: 2 Holes, 634 Feet		B: 2 Holes 360 Feet		C: 6 Holes 1350 Feet		D: 2 Holes, 611 Feet		E: 6 Holes, 2091 Feet		Total: 18 Holes 5046 Feet	
	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.	Total	Per Ft.
Labor on drills	574 33	.905	163 63	.455	1162 86	.862	411 61	.674	1267 84	.606	3580 27	.709
Firemen	240 25	.379	95 87	.266	459 47	.338	161 97	.265	431 68	.206	1387 24	.275
Chopping wood	214 62	.339	150 99	.419	444 92	.329	76 83	.126	378 65	.182	1266 01	.251
Camp account	313 70	.495	186 94	.519	804 45	.595	393 60	.644	1509 75	.722	3208 44	.636
Bits & Ream on drills	104 66	.165	14 30	.040	117 65	.087	84 90	.138	263 96	.126	585 47	.116
Steffler & Ream on mchy	61 99	.097	7 20	.020	122 06	.092	46 46	.076	202 80	.097	440 51	.088
Carbons	465 02	.733	81 56	.227	282 51	.209	337 88	.553	500 00	.239	1660 97	.330
Superintendence	109 13	.172	125 00	.347	297 50	.220	64 75	.106	410 00	.196	1006 38	.199
Total and cost per foot	$ 2083 70	$ 3.286	$ 825 49	$ 2.293	$ 3689 42	$ 2.732	$ 1578 00	$ 2.582	$ 4964 68	$ 2.374	$ 13141 29	$ 2.604

J. Parke Channing, at Various Places in Michigan.

"A," was in iron slates, diorite and quartz-porphyry; holes drilled from bottom of 70 ft pit; average advance 5 ft. per shift. "B" in dioritic schist and some jasper; average advance 6 ft. per shift. "C" was a series of fan holes from bottom of 95 ft. pit; mostly hard and broken iron slates; average progress 5 ft. per shift. "D" was of two holes from a shanty with stand pipe 17 and 20 feet respectively; ten shifts on the stand pipes, 44 on the drilling; actual progress in the rock 14 ft. per shift; material, hornblende schist, jasper and quartzite. "E" was a series of fan holes from the bottom of a wet pit; material quartzite; rate of progress at beginning each hole 18 to 20 feet per shift; average rate 8 feet.

TABLE III.—EAST NEW YORK MINE, ISHPEMING, MICH.

						Total cost.	Per ft.
Labor	400¼ days	setter	@	$3	1200.75	2506.10	.669
	372 "	runner	@	2.25	837.00		
	230¼ "	"	@	2.00	460.50		
	4½ "	laborer	@	1.75	7.85		
Carbon 68½ karets @ $15.144						1035.47	.276
Bits, lifters, shells and barrels and rprs						433.81	.115
Oil, candles, waste, and supplies						128.09	.035
Estimated cost compressed air						374.60	.100
Total						$4478.07	$1.195

Number holes drilled	28
Drilled in hematite	193 feet.
" " jasper	646 "
" " mixed ore	986 "
" " dioritic schist	1921 "
Total drilling	3746 "
No. of ten hour shifts drill was running including moving and setting up	603 feet.
Amount drilling per 10 hour shift	6.2 "

TABLE IV. MINNESOTA IRON COMPANY. TWENTY MONTHS FROM MAY 1, 1894 TO DEC. 31, 1895.

Mines.	Feet drilled.	Carbon.	Cost per foot.	Supplies and oils.	Cost per foot.	Fuel.	Cost per foot.	Shop labor and material.	Cost per foot.	Pay roll.	Cost per foot.	Total cost.	Cost per foot.
No. 1 Mine	697.11	456.07	.653	153.63	.220	27.92	.040	64.75	.093	308.68	.442	1011.05	1.448
No. 5 Mine	62.5	21.80	.349	9.05	.145	5.52	.088	15.	.240	22.75	.364	74.12	1.186
No. 7 Mine	422.	306.90	.727	26.76	.063	16.88	.040	4.20	.010	133.74	.317	488.48	1.157
No. 8 Mine	12329.9	3803.05	.308	750.40	.061	497.07	.040	595.06	.048	3229.66	.262	8875.24	.719
	13512.1	4587.82	.340	939.84	.070	547.39	.040	679.01	.050	3694.83	.273	10448.89	.773

NOTE.—This drilling was all done in the back stopes, almost every foot being in the ore. The drills used were the Sullivan make, "E" size, the holes being 1⅝" in diameter, and from 10 to 40 ft. deep, the machines being operated by compressed air.

TABLE V.—CLEVELAND MINE, ISHPEMING, MICHIGAN, 1892.

Underground drilling	6075 feet.
Surface "	1414 "
Standpipe sunk	470 "
Total distance run	7959 "
Actual drilling time undg.	672 shifts.
" " " on surf.	165 "
Time of foreman, setter, moving, and standpiping	1314 "
Total time worked	2151 "

Av. progress per man per shift	3.70 feet.
" " " drill " "	
actually running	8.95 "
Weight of carbon consumed	111. karets.
Dist. drilled per kt. of carbon consumed	67.38 feet.

	Amount.	Per foot.
Cost of carbon	1887.	.237
" " supplies and oils	134.13	.017
" " fuel	360.73	.045
" " shop material, etc.	663.36	.083
Pay roll	4000 03	.502
Total cost	$7045.25	$.884

PRACTICAL ASSAYING AT MINES AND WORKS.

By H. Van F. Furman.

IN the past ten or twelve years a great advance has been made in the United States in the art of assaying and technical chemical analysis. The assayer or chemist of a decade since would be utterly unable "to hold up his end of the line" in a modern metallurgical works. While rapidity and the ability to execute a large amount of work in a given time have been the points which have seen the greatest development, accuracy has not been overlooked. There has probably never been a period in the history of the business when margins were so small and competition was so great, and hence when greater accuracy was required. In the early days of smelting in the United States the margins on ores purchased were generally large. In those days the shipper did not exercise the same care to check the returns made by the purchaser as at present. Frequently there was no competition, and the seller was compelled to accept what the purchaser would give for a lot. Under the fierce competition and improved methods of the present day all this has been changed.

While it is true that a majority of our best assayers and chemists received their preliminary training in a technical school, the courses of instruction in these schools have hardly kept up with practical progress and the requirements of the times. A graduate of one of our technical schools who obtains a position at a modern works will first have to forget a great deal of that which he has been taught. This lesson having been learned, and habits of precision having been acquired, he will probably become an excellent workman. Should the student in the laboratory of one of our schools be presented with some thirty or forty samples of ore in the morning with the request that the gold and silver contents of each be accurately determined,—the report to be made the same afternoon,—he would probably regard the task as impossible. Should the task be undertaken, he would probably become so hopelessly mixed and nervous that his results would have but little value. Such, however, is not an unusual day's work in a modern establishment, and at many mines from one hundred to one hundred and fifty determinations of gold and silver are frequently required in the course of a day. Thirty control samples for gold and silver, each sample requiring at least duplicate determinations of both the gold and silver, are often received in a modern metallurgical works. Seventy-five determinations in the analytical laboratory will not be considered unusual for a modern chemist.

The young graduate, upon assuming a position at a mine or reduction works, will have straightway to acquire system, rapidity, and accuracy. The first is absolutely essential, and, until a proper system is adopted and carefully carried out, good results can not be expected. Herein lies a dividing line between the school and shop-work. In the school the student will be given two or three samples, and ample time to obtain his results; in the shop the operator will be given a large number of samples, and required to furnish the results in a limited time. This can be accomplished only by having the work so systematically arranged that a large number of determinations can be carried out simultaneously. In a well-conducted office twenty-five to thirty-five fusions or scorifications will be carried out together. In the same manner a large number of cupellations—from fifty to seventy-five—are usually run simultaneously. In this way the different determinations are carried through the separate steps in series, thus saving a great deal of time and labor.

Rapidity is frequently of the utmost importance. At a mine the miners and ore sorters will frequently have to wait for the assayer's results before proceeding with their work. At a metallurgical works the working of the plant and the quality of the product will often be largely dependent upon the result of an analysis, which must be rapidly performed to be of value.

Accuracy within narrow limits is absolutely essential. When it is considered that over $100,000 may be paid out for ore, etc., as the result of one day's assays at a modern plant, the importance of accuracy becomes apparent. The results obtained in commercial gold and silver assaying, while not scientifically accurate, are probably much nearer the truth than those obtained by any other commercial industry. There is a mistaken idea in the mind of the uninitiated that the fire assay for gold and silver invariably yields results far below the actual contents. This idea is not without foundation, as there must be a loss of precious metals under fire processes. However, in a series of experiments recently conducted by the writer to demonstrate that which had frequently been demonstrated,—that these losses were not as great as generally supposed,—the loss of silver in the scorification assay was found to be 2.54 per cent., and the loss in the crucible assay was found to be 2.58 per cent. The loss of gold was nominal (scorification 0.8 per cent., and crucible 0.3 per cent.). In another series of experiments on the assay of base (lead) bullion the silver loss was found to be 1.55 per cent., while the gold loss was trifling. In the fire assay of silver bullion a great number of experiments show the average loss to be about 1 per cent. However, when silver bullion is assayed by the fire method, the losses are always corrected by running

a proof assay with each set of determinations. The average loss of gold in the assay of gold bullion is about one part in one thousand, or 0.1 per cent. This loss is invariably allowed for, and corrected, by running a proof assay with each set of bullion assays. As the losses in ore assaying are well known, and allowed for in the purchase of ores by our modern works, they can not be considered as of serious moment.

The limits of accuracy to be attained will depend largely upon the character of the work. Mine samples do not require as much care as control samples upon which the ore is sold. One determination for gold or silver on each mine sample is usually all that is required. The assayer at a reduction works will frequently receive samples in handling which speed is of more importance than extreme accuracy. As to the allowable limits of variation on control samples, it may be considered as 0.5 ounce silver and 0.1 ounce gold on ores assaying up to 100 ounces silver and 3 ounces gold per ton. However, no exact rule can be given as to the allowable variation. Many samples of high-grade ore will be encountered with which the only safe rule, on account of the variations in individual assays which may be expected, is to run a large number of assays and then average the results. The modern assayer must be a man of judgment as well as of skill.

The sampling of ores and metallurgical products, while not properly coming within the scope of the assayer's work, is a subject which should be thoroughly familiar to the practical assayer. Unless the samples truly represent the mass or lot from which they were taken, the subsequent assays will be valueless. The assayer at a mine or works generally receives the samples already prepared, but there are occasions when he is called upon to take his own sample. Hence the art of sampling should be thoroughly understood by the assayer. As it is not within the scope of this article to take up the subject of sampling, we will begin with the point at which the sample is delivered to the assayer.

The ore sample is usually delivered to the assay office in a sealed bottle, or paper sack, with the assay number plainly marked upon it. The works generally make three samples; one to be delivered to the shipper, one to the works assayer, and one to be held in reserve for delivery to an independent assayer, as umpire, in case of a disagreement between the works and the shipper. Each of these samples has been carefully and indiscriminately cut out of the general sample of the lot, and passed through an 80- or 100-mesh (the latter is now the Colorado practice on gold ores) sieve.

The assayer, on commencing work in the morning, usually has a number of samples on hand. Each sample is taken up by itself,

spread upon a piece of rubber cloth, and thoroughly mixed by means of a steel spatula, the pile being finally spread out into a flat layer of about one-eighth inch in thickness. From this layer the assay samples are taken with a small steel spatula, going over the layer and taking a portion on the point of a knife from each part. Care should be exercised here to always dip the knife down to the bottom of the layer, so that each portion will represent the layer from top to bottom. The portion usually taken in Colorado for each gold assay is $\frac{1}{2}$ assay ton.* This is introduced into a 20-gram crucible, together with the proper fluxes, which consist of litharge, sodium bicarbonate, borax glass, a reducing agent (as flour or argols), or an oxidizing agent (as nitre), according to the requirements, and such other fluxes as may be necessary. The necessary fluxes have to be added according to the mineralogical composition of the ore. It is largely here that the assayer's skill and experience enable him to obtain correct results. According to the method taught in many technical schools, when the assayer is in doubt as to the proper charge, he should run a preliminary assay. The practical assayer has no time for preliminary assays, but must judge the character of the ore simply by eye-inspection; when in doubt, the writer has found that, by placing about half a gram of the ore on a watch glass and vanning with a little water to separate the lighter and heavier minerals, and then by inspection judging as to the minerals present and their approximate amounts, the character of the sample could be determined sufficiently for assay purposes, and with a small expenditure of time. According to the Colorado practice, most gold assays are run by the crucible method, and most silver assays by the scorification method. It is hardly within the scope of this article to discuss the reasons for the adoption of these methods, but it is sufficient to say that they appear to give the best results.

After weighing out the gold charges, the silver assays are weighed out, $\frac{1}{10}$ assay ton being the general charge. On control samples three or more charges will be weighed out and introduced into a scorifier, together with the proper amount of pure granulated test lead, half of which is mixed with the ore and half of which is added as a cover to the charge. In addition, a little borax glass, and occasionally other fluxes, are added to the charge. In this manner the assayer proceeds with each sample, a convenient system being that adopted by the writer as follows: the assay number of the first sample weighed out is

* The Assay-Ton System of Weights was devised by Prof. Chas. F. Chandler of Columbia College. As there are 29,166.6 troy ounces in one ton avoirdupois (2,000 pounds), the assay ton contains 29.166.6 grams; hence, if one assay ton of ore is taken for assay, and the resulting button weighs 10 milligrams, the assay value of the ore will be 10 ounces per ton. One ounce per ton is 0.00343 per cent.

entered in the assayer's memorandum-book at the top of the page for the day. This becomes Number 1, and, should a duplicate be run, the assay number will appear twice, the duplicate becoming Number 2 of the day's work. In this manner the weighing out is proceeded with, the charges being arranged somewhat as follows:

1, 2, 3, 4,
5, 6, 7, 8,
9, 10, 11, 12, etc.

According to this system, we always begin at the upper left hand and read exactly as a page of a book is read. Provided the same relative order is always retained, it is immaterial how many charges are introduced into the furnace at a time; they cannot be interchanged, and any charge can at any time be picked out and separated from the others, if necessary.

When a sufficient number of charges are prepared, they are introduced into the furnace for fusion or scorification. When the fusion or scorification is finished, the charges are removed from the furnace and poured into conical iron moulds, the same relative order being retained. As soon as the slags and buttons have cooled, which generally requires about fifteen minutes, the lead buttons are removed from the slag and pounded on the anvil into cubes. Each cube of lead is now introduced into a hot cupel in the muffle furnace, and the door is closed until all begin to cupel, when it is opened, and cupellation is continued until the buttons brighten, thus showing the elimination of the base metals.

As has been remarked, the Colorado practice is to run the gold assays by the crucible method, the fusions being performed in the muffle furnace, and the silver assays by the scorification process. When this method is adopted, it is customary to add a small piece of pure silver to the gold crucible assays, in order to insure the parting of the button. The gold-silver beads, resulting from the gold assays, are flattened by a few blows of a hammer on a steel anvil, and are then parted for their gold contents. The method of parting generally adopted consists in introducing the flattened button into a small porcelain crucible, adding dilute nitric acid, and heating until action of the acid apparently ceases. The solution of silver nitrate is poured off, strong nitric acid is added, and the buttons are boiled for four minutes. This solution is then decanted off, and the gold is washed twice with distilled water, and, after drying and annealing, is weighed. The balance used for this purpose will weigh to at least 0.01 milligram, and should be used only for this purpose. The silver-gold buttons resulting from the scorification assay are removed from the cupel, brushed with a stiff bristle brush to remove adhering particles

of bone-ash, etc., and weighed, the gold as obtained in the crucible assay being deducted, and the difference being the silver assay of the ore.

Such, briefly, is the work required of the assayer, although, if employed at a smelting and refining establishment, he will be required, in addition to the ore assays, to make assays of base bullion, mattes, slags, doré bullion, silver and gold bullion, by-products, etc. Each of these assays requires special methods, which it is unnecessary to discuss further than to say that the same accuracy and care are essential throughout.

The form of report to be handed in by the assayer will depend largely upon the system adopted by the works. An admirable system adopted by one of our prominent reduction works is this: the samples delivered to the assayer are marked simply with the assay number of the lot, and each afternoon the assayer fills out his report containing the assay, or works lot number, together with the results on each number. Under this system the assayer does not know, nor has he any interest in, one sample above another. This system also enables the management to check the assay returns at all times and without the knowledge of the assayer. At another establishment, where a number of men are employed in the assay office and laboratory, a different system is adopted. Here all samples are delivered to a head assayer, who examines each, marks it with the constituents to be determined, and remarks as to the general character of the sample. The samples are then turned over to the assayers for the proper determinations.

REVIEW OF THE ENGINEERING PRESS

WITH A DESCRIPTIVE INDEX TO THE LEADNIG ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles o the month which are deemed of most importance ; (2) to supply a descriptive Index to the leading articles published currently in the engineering, architectural and scientific press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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Age of Steel, The *w.* $3. St. Louis.
American Architect, The *w.* $6. Boston.
Am. Chemical Journal. *b-m.* $4. Baltimore.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1. Columbus, O.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.*. $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Banker's Magazine. *m.* 18*s.* London.
Bankers Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $1.50. Ottawa
Century Magazine. *m.* $4. New York
Chautauquan, The *m.* $2. Meadville, Pa.
Clay Record. *s-m.* $1. Chicago.
Colliery Engineer. *m.* $2. Scranton, Pa
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Contemporary Review. *m.* $4.50. London
Cosmopolitan, The *m.* $1.20. New York.
Domestic Engineering. *m.* $2. Chicago
Electric Power. *m.* $2. New York.
Electric Railway Gazette. *w.* $3. New York
Electrical Age. *w.* $3. New York.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York

Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fairplay. *w.* 32*s.* 6*d.* London.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Geological Magazine, The. *m.* 18*s.* London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery. *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining. *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8*s.* London.
Mining World, The. *w.* 21*s.* London.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Overland Monthly. *m.* $3. San Francisco.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1 New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York
Rhodes' Journal of Banking. *m.* $5. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

The Boston Public Library.

SCRIBNER'S MAGAZINE for January contained an article by Mr. T. R. Sullivan on the new Boston Public Library building, —one of those descriptive articles that pass current for architectural criticism, and yet accomplish very little in the diffusion of architectural knowledge. The pictures which accompany the text are good.

The Boston Public Library building is easily one of the most notable public structures in America. It is a noble addition to any city group, and its situation on Copley square, while adding somewhat to the variety of edifices that surround that spot, is perhaps as good a site as could have been found for it. The real architectural importance of this building to the public is that it is a great municipal undertaking, planned for strictly utilitarian uses, to which has been given an artistic and beautiful form, making it as fine a building as has been produced in America. It is not possible, in the space of a few paragraphs, to summarize the ar qualities of this structure. It is monumental and stately, refined and imposing. True, the main façade is a free following after the façade of the Bibliothèque St Geneviève at Paris; but the copying has not been slavish or accurate. On the contrary, the original design has been made the basis of the present one, and enlarged and bettered, until the Boston building may rightly be taken as a true and direct successor to the Paris building. This view is not that generally taken by the architects who did not have the opportunity to build this structure; but such must be the view of every one who fairly compares the two.

The monumental quality that dominates the façade is a leading element throughout the building. Its plan—an open court in the center surrounded on all sides by the library building—is perhaps wanting in that compactness which is necessary to economical planning in libraries, but a certain monumental effect has been maintained throughout all the public rooms, while the inner parts—the stacks and smaller rooms for readers and students—appear, save in some cases where the light is not quite ample, to be entirely sufficient for their purpose.

There is a monumental vestibule and stairway, the latter rich in costly marble, but injured by the narrowing of the stair arch, yet having a splendor of its own that is entirely appropriate to its purpose. The painted decorations which are to surround the upper walls are not yet all in place, but the green and blue pictures on the main wall are certainly destined to lead to much discussion among the uneducated, whose first glimpse of modern art —truly modern art, that is—will be derived from contemplating them. Bates Hall is unquestionably a splendid apartment, though a good deal of the effect of its proportions is lost, because it is usually entered at the center of the side, where the perspective of the arches is quite without value and the great size of the apartment not fully realized. The stairway leading to the upper hall, which Mr. Sargeant has partly decorated, is by no means in keeping with the corridor to which it leads, and the corridor itself is scarcely well proportioned or happily placed. Still, there are in these rooms many positive results of genuine artistic value that quite justify any eulogy. The building is supplied with many mechanical devices that add to its efficiency, but with which the architectural critic seldom busies himself. They should not, however, be neglected in any study of the building.

John Stewardson on American Architecture.

THERE is a melancholy interest in the paper on "Architecture in America: A Forecast," contributed by John Stewardson to *Lippincott's Magazine* for January;

for on the sixth day of that month its accomplished author was drowned, and one of the most active and useful lives in American architecture brought to a sudden end. It was perhaps not the least of Mr. Stewardson's advantages that he should have been brought up in Philadelphia and have entered into practice there. In no other city was the architectural spirit less developed, and in no other place, it might with truth be said, were such eccentric designs accepted as the best of architecture. The architectural state of his city at the time of Stewardson's death was very different. One of a little band of architects who labored for the art in its highest sense, he was one of the most earnest supporters of that movement which has wrought a change in Philadelphia's buildings, and made many of her structures real works of art, which, in a few instances, are worth going many miles to see.

Mr. Stewardson was an ardent adherent of the French faith which is now having full swing in the United States. His article in *Lippincott's* was written to point out what he conceived to be our architectural salvation through that faith. One does not need to agree with its writer to admit the earnestness of his argument or the value of his own work. This, fortunately enough, was far from illustrating the faith in foreign ideas which Mr. Stewardson himself felt. And his article is characterized by the same liberal spirit. It is a notable thing to find in a man bred in the Beaux-Arts the admission that the treatment of business buildings in France is monotonous, and that their interest ceases with their plans and their proportions: It is refreshing to find one so trained confessing that the detail of these buildings is, as a rule, crude and unfeeling. It is to be hoped that Mr. Stewardson's associates will practise the same system of truth-telling that he has done in this article. There can be no dispute as to the facts; yet how many of the members of the Beaux Arts Society of Architects, New York, are so frank?

On the contrary, it is the general tendency of these gentlemen to insist on the general perfection of the French style in every particular, and to set forth these perfections as their own basis for following it. Fortunately Mr. Stewardson practised what he preached. None of his more important buildings exhibited that formalism which we are rapidly coming to associate with classicism, and which is identical with it in France. On the contrary his designs were well studied and original, with a final effect of great interest, and quite devoid of those eccentricities of mannerism—if they may be so styled—in which his *confrères* delight.

The death of Mr. Stewardson is a distinct loss to Philadelphia, and a loss to the cause of good architecture in America. The hope for the future cannot, indeed, be in that cold classicism for which France is famous, but in a rational treatment of all problems in themselves; and with the truth of this statement Mr. Stewardson would himself, probably, have been the first to agree.

Herbert Spencer on the Origin of Architects.

THAN Mr. Herbert Spencer there is no more weighty philosopher living; yet his most ardent admirer must admit that the chapter on architects in the series on "Professional Institutions" which he is contributing to the *Contemporary Review* is one of the slightest pieces of work he has done, and, in fact, as valueless a contribution to architectural literature as has been made by any writer within the past decade. Mr. Spencer's object is to trace the origin of the architect, and he begins his task without any consideration of the origin and nature of architecture, and by only the briefest reference to the primitive man's knowledge of the art of building. He then proceeds to remark that "we are at once met by the broad fact that the earliest architecture bequeathed by ancient nations was an outcome of ancestor-worship." In itself this may be true enough, but it entirely ignores the earlier fact that man certainly built structures for shelter before the buildings for worship which he bequeathed to those who came after him.

The inference of the philosopher, who continues his work with a most philosophic disregard of definitions and positions, is that the first architects were priests, though not a hint is given of what architects are. The priestly origin of architects is supported by quotations from various writers, whose competency here is not always evident. Mr. Spencer concludes his essay in this manner:

"Chiefly for form's sake reference must be made to the gathering together and consolidation which, in our times, has been set up in the architect's profession. There is little to remark further than that, the members of it having been but a few during earlier periods, when the amount of architectural building was relatively small, segregation and association of them could scarcely occur. Recently, however, there has been formed an Institute of Architects, and the body of men devoted to the art is tending more and more to make itself definite by imposing tests of qualification.

"At the same time cultivation of the art and maintenance of the interests of those pursuing it are achieved by sundry special periodicals."

Had Mr. Spencer undertaken the study of architects with that breadth of view and penetration of thought to which he has accustomed the readers of his philosophical dissertations, he would have found a singular confirmation of his religious theory in certain architectural tendencies of the present day. Apparently, however, the fame of that noble American band, the Frenchites, has not yet extended to those sources from which he derives his architectural information. Yet the doings of these people here in America would clearly have strengthened the theory put forth. They are a consecrated body of men, with a peculiar quality of their own that at once stamps them as a species of high-priests of their art. The development of such a coterie at this late day, so remote from the origin of architects, could not, had it been known to Mr. Spencer, have failed to impress him as a most singular and interesting survival at a most unexpected time and in a most unexpected quarter. It is hard to believe, moreover, that this company of Chosen Ones would not have materially strengthened the philosopher in his views.

FRENSHAM HALL, HASLEMERE.—Messrs. Bradley & Dubbins, Architects.

Some Recent Church Designs.

DURING the past few months the *Amer-*

ican Architect has been printing a series of papers entitled "Art in the Modern Church," by Mr. Barr Ferree. It was, perhaps, not necessary to compose a treatise to demonstrate that the general standard of church architecture in America is very low; but it may have been of some value to point out that a church is, by its nature, a very different sort of building from a hotel, a house, a commercial building, or any other structure. In other words, we have in the present day almost forgotten the fact that the church has a meaning and purpose quite distinct from that of other buildings. It was to point out this thesis, and support it by copious reference to contemporary buildings, that the series in question was prepared.

Some recent designs of churches published in the architectural journals show that no definite progress is being made in this form of architecture, which has certainly not been as much improved within the last ten years as commercial architecture, or perhaps as much as house architecture. Of course, we live in a commercial age, in which everything save the ornamental receives close attention. Churches cannot well be dispensed with, but their nature is not as utilitarian as the larger number of modern types of building. Compare, for example, the design for the new cathedral at Berlin (*American Architect*, Jan. 18) with a design for a new cathedral at Washington (*Harper's Weekly*, January 25). In both cases the idea of the architect was to devise a monumental structure, and to work on this basis to the extent of his individual capacity or the intelligence of those employed by him. In neither case has any effort been made to prepare a design which should have, first of all, a religious quality, or a distinctive character unmistakably Christian. We recognize these buildings as churches, not because they are of a Christian type of architecture, but because, by the process of exclusion, we see they cannot possibly be anything else!

The design for a Town Church (*Builder*, January 11) by a student at the Royal Academy is, of course, only a bit of student work; yet it illustrates, in a measure,

the prevailing conceptions of church architecture. In this instance they are found to be a certain eccentricity of design, a persistent employment of the vault and dome, and a hardness and ugliness of parts that are neither pleasing or religious. Sir A. W. Blomfield's restoration of St. Peter's, Eaton square, London, is scarcely better than any of these, so far as the architectural parts are concerned, though a certain ecclesiastical effect is obtained by the furnishings and decorations. Saviour's Priory Chapel, Haggerstone, England (*Builder*, Jan. 18), is hardly likely, in construction, to be as effective as the drawing printed in *The Builder*.

More interesting than any of these is the design for St. Andrew's church, Bacsom Bascombe, England (*Builder*, Jan. 4), —a truly poetic design, full of intense artistic feeling, revealing a deep personal interest and characterized by a purposeful quality which we instinctively recognize as distinct and individual.

The designing of churches is really a consecrated task, which should be approached in a very different spirit from that with which one begins an ordinary piece of work. The church building must be studied for its religious effect rather than for its esthetic value.

The Paris Exposition for 1900.

THE AMERICAN ARCHITECT says that the Paris Exposition of 1900 is developing under difficulties. In particular it is meeting with opposition in the Chamber of Deputies. The last proceeding of this body in this direction is to forbid the use of any part of the Champs Elysées for the exhibition, to interdict the removal or rebuilding of the Palais de l'Industrie, and to direct that all the exhibition buildings shall be confined to the left bank of the Seine. This decree upsets completely the fine plans for a monumental bridge, extending from one grand cluster of palaces on the right bank, to another on the left, and restricts the exhibition within a smaller space than was occupied by that of 1889. The Municipal Council of Paris is also disaffected.

Illustrations of the Month.

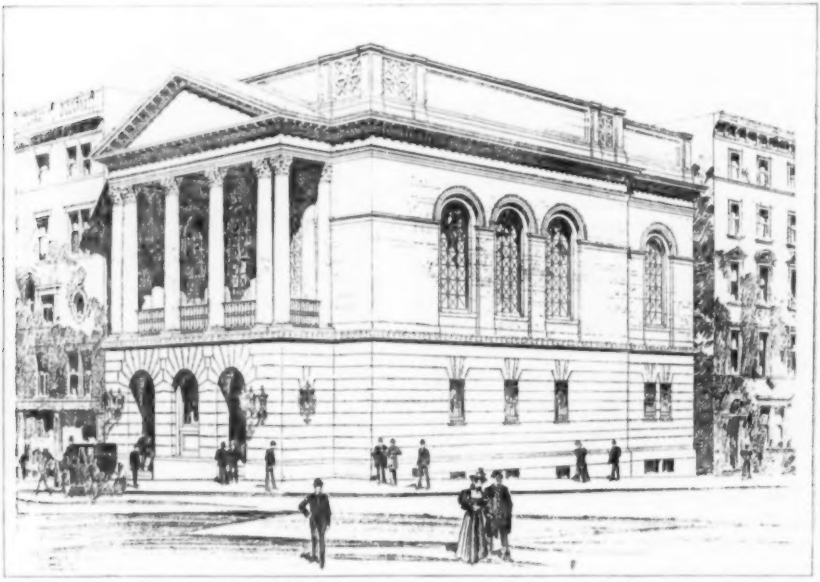
Architecture and Building publishes (January 11) a beautiful photograph of the fine house for Mrs. Josephine Schmid on Fifth avenue in New York, by Richard Howland Hunt. It is in the château style in which the architect's father achieved his most notable successes, and a work of genuine interest. It may be questioned, however, if the very effective high-sloping roof does not entail some unnecessary loss of space in the upper floors. The same journal also publishes (January 4) a line

AMERICAN SURETY BUILDING.

drawing of the American Surety Building in New York, a structure which has some distinction by reason of its small base of about eighty-five feet and its very great height of twenty-one stories. The entrance, with its porch of Ionic columns, doubled in the centre, and its six statues above, is immensely successful, and, when completed, will unquestionably be one of the finest ornaments to Broadway.

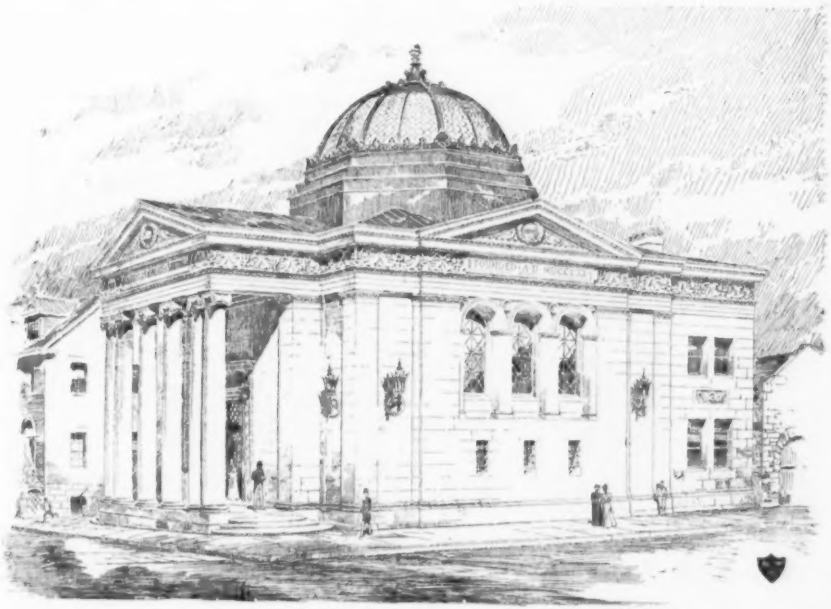
The photogravure plates of the *Inland Architect* (January) reproduce a number of interesting buildings, chiefly residences in Chicago. Of seven houses shown five are provided with classic or Renaissance columns, and other features which now appear to be regarded as essential to "modern" design, thereby certainly increasing the use of fine stones and marbles, though indicative of a rather singular form of procedure, since architectural effect should consist in more than a setting up of two or more columns before a doorway or for supporting a porch. Several of the plates of this number are quite unneccessarily given up to illustrating a competition instituted by the Chicago Architectural Club. No literary journal would think of publishing the compositions of college students; why, then, should the experimental work of architectural students be perpetuated in published form?

The *American Architect* publishes some superb photographs of the interior of the Metropolitan Club House in New York, technically the most beautiful illustrations of the month. It prints, also, two interesting photographs of the Johnston Emergency Hospital at Milwaukee. In the same number (January 25) it reproduces three competitive plans for a new savings bank at New Bedford, by Peabody & Stearns, Andrews, Jaques & Rantoul, and Charles Brigham, whose design was selected. Why architects of the standing of these firms should have been asked to compete for so small a piece of work as this is not clear; certainly a satisfactory design might have been expected of either of them. The accepted design presents an exterior in two stories, with a classic portico above on the main front.



ACCEPTED DESIGN FOR THE NEW BEDFORD SAVINGS BANK BUILDING, NEW BEDFORD, MASS.
CHARLES BRIGHAM, ARCHITECT

Within, the building is found to be but one story high, the portico being at the level of an inner gallery, and thus emphasizing a secondary feature. The design by Messrs. Andrews, Jaques & Rantoul is much more logical. The portico is on a level with the street, and the building seems to be—what it really is—a single-story structure. The design submitted by Messrs. Peabody and Stearns is, properly enough, a single-story building, but so closely modeled on the paper designs of French architects as to seem almost like a reproduction



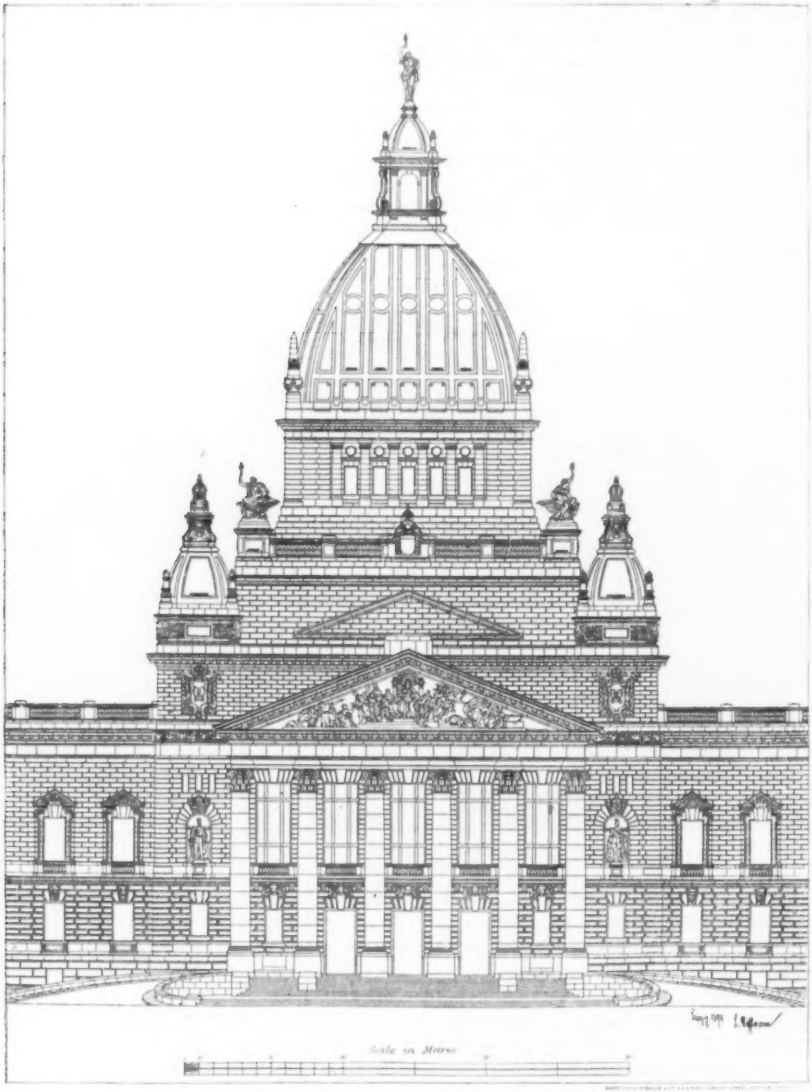
COMPETITIVE DESIGN FOR THE NEW BEDFORD SAVINGS BANK BUILDING, NEW BEDFORD, MASS.
ANDREWS, JAQUES & RANTOUL, ARCHITECTS.

from the *Croquis d'Architecture.*

A melancholy interest attaches to the photographs of the interiors of the superb house of Lord Leighton, reproduced in several numbers of *The Architect.* Lord Leighton's interest in architecture was that of a friendly and interested critic, and the honors bestowed upon him by the Royal Institute of British Architects, which gave him the Royal Gold Medal and an Honorary Fellowship, testify to the loving regard and estimation in which he was eld by his countrymen. By long odds the most conspicuous figure in contemporary English art, Lord Leighton's death leaves a void in the art and social world of England that will not be speedily filled.

The *Architectural Record* interrupts its series of "Architectural Aberrations" to find space for praise of Mr. Hardenbergh's beautiful Wolfe Building in New York, a finely picturesque structure, whose genuine beauty is the more remarkable because of its strictly commercial and utilitarian nature. It is, however, somewhat of a shock to read in our contemporary that one of the merits of this building is a grace that a painter might like to paint! There could hardly be a greater misconception of the nature of commercial architecture than a statement like this. It is doubtless an agreeable thing to have a paintable building, so far as looks go or esthetic enjoyment; but to set this down as one of the notable and important characteristics of a commercial building—as one of the reasons, to speak plainly, for admiring it—is certainly to confess the densest ignorance of the subject.

It is the custom of some of the British architectural journals to make their New Year's number a special issue, with many extra illustrations. This year *The Builder* leads in the number and importance of its pictures, its issue for January 4 being an especially rich and valuable one. Among English buildings it publishes a photograph of the New National Portrait Gallery in London; a study for the west front of the proposed church of St. Andrew, Boscombe (in colors), by Mr. H. Wilson; a view and plan of Kirkstall Abbey in its series of the Abbeys of Great Britain; a four-page



THE IMPERIAL LAW COURTS, LEIPSIC: ELEVATION OF CENTRE OF PRINCIPAL FRONT.—Hans Ludwig Hofmann, Architect.

drawing, "Under the West Front Arches of Peterborough Cathedral," by Mr. G. C. Horsley, a striking picture from a novel point of view; and a view of Ludgate, London, in the time of Henry VIII,—one of Mr. H. W. Brewer's imaginative and interesting restorations. Italy is represented by a front elevation of the new Vittorio Emanuele theater at Palermo, by Mr. G. B. F. Basile; Germany by a view, plans, and part of the front elevation of the Imperial Law Courts at Leipsic, by Mr. L. Hoffmann; and France by a photograph of the monument to Meissonier in the "Jardin de *l'Infante*" of the Louvre, by Mr. Mercié, and one of the painted ceiling, "L'Apothéose des Lettres," in the Salon des Lettres in the Hotel de Ville at Paris, by M. Jules Lefebre. In a subsequent issue *The Builder* gives three drawings of a design for a Town Church which won for Mr. P. Rodeck the Royal Academy Gold Medal and Travelling Studentship for 1895,—a design we hope never to see built.

THE ENGINEERING INDEX—1896.

Current Illustrations and Leading Articles on Architecture and Building in the American and English Architectural and Engineering Journals—See Introductory.

Index to Illustrations.

APARTMENT HOUSES.—For C. E. Rector, by J. M. Van Osdel, In. Archt., Jan.—Entrance, 105th st., New York, by R. S. Townsend, Archt. and Build., Jan. 25.

ARMORY.—Jersey City, N. J., by C. A. Gifford, Archt. & Build., Jan. 18.

CHURCHES.—Trinity Evangelical Lutheran (with plan), Johnstown, Pa., by J. A. Dempwolf, Amer. Archt., Jan. 11.—New Cathedral, Berlin, Prussia, by Prof. Ruschdorf, ibid., Jan. 18.—Proposed, of St. Andrews, Bascombe, Eng., by H. Wilson, Builder, Jan 4.—At Hagerstone, Eng. (with plan and interior), by C. H. M. Mileham, Ibid., Jan. 18.—St. Peter's, London, Eng. (3), restored by Sir A. W. Blomfield, Archt., Jan. 3, 10, 17.—Church of the Immaculate Conception, Yonkers, N. Y., L. J. O'Conner, Archt. and Build., Jan. 25.

CLUB HOUSES.—Golf and Country Club, Ridgefield, Ct., by W. A. Bates, Amer. Archt., Jan. 4.—Metropolitan Club, New York (3 interiors of south lounging room), by McKim, Meade and White, ibid., Jan 11.—Hall of Mercers Company (staircase), London, Eng., ibid., Jan. 18.—Calumet Club, Manchester, N. H. (with interior), by W. M. Butterfield, In. Archt., Jan.

COMMERCIAL BUILDINGS.—Savings Bank, Cedar Rapids, Ia., by Josselyn and Taylor, Amer. Archt., Jan. 11.—Linder's Real Estate Co., St. Louis, Mo., by Shepley, Rutan and Coolidge, ibid, Jan. 18.—For Lindsay Bros., Minneapolis, Minn, by H. W. Jones, ibid., Jan. 25.—Savings Bank, New Bedford, Mass. (with plans), by C. Brigham, Andrews, Jaques and Rantoul, Peabody and Stearns, ibid.—American Surety Co., N. Y., by B. Price, Archt. and Build., Jan. 14.—Store, Toronto, Can., by Curry, Baker and Co., ibid., Jan. 18.—For Black and Meyer and N. Coldwater Bros., Rochester, N. Y., by Nolan, Nolan, and Stern, In. Archt., Jan.—Store, P. Jamison, Toronto, Can., by Curry, Baker and Co., Canadian Archt., Jan.—Public Market, Winnipeg, Man., by G. Browne, ibid.—For E. Fletcher and Co., Birmingham, Eng., by E. Nicol and Goodman, Archt., Jan. 10.—Warren Chambers, Boston, Mass., by Ball and Dabney (with plan), Brickbuilder, Jan.—King Building, Boston, Mass. (with plan), by W. W. Lewis, ibid.

COMMERCIAL BUILDINGS—INTERIORS.—Bank, Bolton, Eng., by Bradshaw and Gass, Amer. Archt., Jan. 4.—Whitehall Court, Victoria Embankment, London, Eng., by Arthur and Green, ibid.—Board Room, P. & O. S. N. Co. offices, Leadenhall St., London, Eng., by T. E. Collcutt, ibid., Jan. 11.—Penny Bank, Yorkshire, Bradford, Eng., by J. Ledingham, ibid., Jan. 18.—Equitable Insurance office, Manchester, Eng., by W. Waddington and Son, ibid., Jan. 25.

COURT HOUSES.—Hennepin County, Minneapolis, Minn. (3), by Long and Keys, Amer. Archt., Jan. 18.—Imperial Law Courts, Leipsic, Germany, (view, plans part elevation), by L. Hoffman, Archt. and Build., Jan. 4.

HISTORICAL.—Gateway to University, Huy, Belgium, Amer. Archt., Jan. 4.—Chartres Cathedral, statues of west portal, ibid.—Collegiate Church of St. Hildebert, Gournay, west front, ibid., Jan. 25.—Peterborough Cathedral, under the west front arches, Builder, Jan. 4.—Ludgate in the time of Henry VIII, H. W. Brewer, ibid.—Kirkstall Abbey (with plan), ibid.—Banqueting House, Whitehall, Eng., measured and drawn by W. R. Davidson, ibid., Jan. 18.—Burgos Cathedral, interior, ibid., Jan. 25.—Burford Church (with interior), restored by A. Webb, Brit. Archt., Jan 3.—Stokesway Castle, view of north tower, Canadian Archt., Jan.—Wells' Cathedral, ibid.—Cloister of San Francesco, Brescia, measured and drawn, Brickbuilder, Jan.

HOSPITALS AND HOMES.—Soldiers' Home, Atchison, Kas., by J. G. Holland, Amer. Archt., Jan. 4.—Johnson Emergency Hospital, Milwaukee, Wis. (with entrance), Ferry and Clas, ibid, Jan. 25.

HOUSES, CITY.—Group on Eighty-sixth-st., N. Y., by G. E. Wood, Amer. Archt., Jan. 11.—At Roxbury, Mass., by E. E. Park, and R. E. Sawyer, ibid, Jan. 25.—For Mrs. J. Schmid, N. Y., by R. H. Hunt, Archt. and Build., Jan. 11.—For S. W. Stevens, Lowell, Mass., by Davis and Raynes, In. Archt., Jan.—Residence, Chicago, Ill., by D. T. Kennard, ibid.—For J. R. Hoxie, Chicago, Ill., by G. L. Harvey, ibid.—For E. Foreman, Chicago, Ill., by C. S. Frost, ibid.—For A. O. Slaughter, Chicago, Ill., by Holabird and

We supply copies of these articles. See introductory.

Roche, ibid.—For Dr. Coolidge, Chicago, Ill., by Shepley, Rutan and Coolidge, ibid.—Residence, London, Ont., by H. Matthews, Canadian Archt., Jan.

HOUSES, COUNTRY.—For A. N. Belding, Rockville, Ct. (with mantel details), by S. J. Brown, Amer. Archt., Jan. 4.—At Weston, Mass. (with plan), by J. T. Kelley, ibid, Jan. 11.—For E. E. Osborn, Evanston, Ill., by T. J. W. Jennings, ibid, Jan. 18.—For C. Whitman, Katonah, N. Y. (with interior), by Lamb and Rich, ibid.—Two Houses, by F. E. Wallis, Archt., and Build., Jan. 4.—For E. J. Bracket, East Orange, N. J., by L. P. Smith, ibid, Jan. 11.—For W. F. Moore, Flatbush, N. Y., by Ludlow and Valentine, ibid, Jan. 18.—For R. F. Putnam, Northampton, Mass., by Putnam and Bayley, ibid.—For J. A. Sawyer, Stamford, Ct., by F. E. Wallis, ibid.—Residence, Evanston, Ill., In. Archt., Jan.—At Swanage, Eng. (with plans), by C. F. A. Voegsey, Brit. Archt., Jan. 17.—For Lord Lovelace, Elmthorpe, Eng., by same, ibid.—Cottage, Isle of Wight, by A. Webb, Builder, Jan. 25.—Frensham Hall, Haslemere, England, by Beazley & Burrows, ibid.—At Knutsford, Cheshire, England, by J. Brooke, ibid.

INTERIORS.—Apartment of Bela Krioztinkovich, architect, Buda-Pesth, Hungary, Amer. Archt., Jan. 4.—Mantel details for A. N. Belding, Rockville, Ct., by S. J. Brown, ibid.—Metropolitan Club, N. Y. (3), by McKim, Mead and White, ibid, Jan. 11.—In house of C. Whitman, Katonah, N. Y., by Lamb and Rich, ibid, Jan. 18.—Decoration of a hotel, Rue Daru, Paris, by M. Rich, ibid.—Hall of Mercers' Company, London, Eng., ibid.—Calumet Club, Manchester, N. H., by W. M. Butterfield, In. Archt., Jan.—Residence of Sir F. Leighton, London, Eng. (3), by G. Atshison, Archt. Jan. 3, 10, 17.—St. Peter's, London, Eng., (3) by A. W. Bloomfield, ibid, Jan. 3, 10, 17.—Chapel, Haggerstone, Eng., by C. H. M. Mileham, Builder, Jan. 18.

LIBRARY.—Newberry Library, Chicago, Ill. (entrance), by H. I. Cobb, Amer. Archt., Jan. 4.

MINNESOTA STATE CAPITOL.—Design by C. K. Dean (view, plan, section), Amer. Archt., Jan. 11.

MONUMENTS.—J. H. Andresson, by J. M. DaSilva, Amer. Archt., Jan. 18.—E. Augier, by Duchesse d'Uzès and L. Parent, ibid, Jan. 25.—Ericsson Statue, N. Y., by J. S. Hartley, Archt. and Build., Jan. 18.—Meissonier, in the "Jardin l'Infante" of the Louvre, by M. Mercie, Builder, Jan. 4.

MUSEUMS.—Museum of Fine Arts, St. Louis, Mo., by Peabody and Stearns, Amer. Archt., Jan. 4.—Museum of Natural History, N. Y. (east wing), by Cady, Berg and See, Archt. and Builder, Jan. 4.—Pavilion for Exposition of 1900, Paris, by P. Salmersheim and A. Ventre, ibid, Jan. 25.—Portrait Gallery, London, Eng., by E. Christian, Builder, Jan. 4.

NEW MUNICIPAL BUILDINGS.—New Municipal Building, King's Lynn, Eng., by Tree and Price, Builder, Jan. 11.—New Record Offices, London, Eng., by J. Taylor, Archt., Jan. 17, 24.—Clerkenwell Town Hall, (2 by C. Evans-Vaughan, ibid, Jan. 24.

SCHOOLS.—General View of Christ's Hospital Schools, Horsham, Eng., by Webb and Bell, Amer. Archt., Jan. 18.—Public School, Millvale, Pa., by Bartberger and East, ibid, Jan. 18.—Technical Institute and Public Library, West Ham, Eng., by E. Nicoll and Goodman, ibid.—At Arlington, Mass., by Gay and Proctor, ibid, Jan. 25.—Bishopsgate Institute (entrance), by C. H. Townsend, ibid.—St. John's Seminary, Wonersh, Surrey, England (with plan) by F. A. Walters, Builder, Jan. 25.

STUDENTS' WORK.—Surgical Hospital, by L. F. Pilcher, Archt. and Build., Jan. 11.—Art School, Chicago Architectural Club Competition (3), by A. B. LeBoutelier, W. L. Welton, J. F. Jackson, In. Archt., Jan.—Town Church, R. A. Gold Medal and Travelling Studentship, 1895, by P. Roderick, Build., Jan. 11.—Jewelry Store Competition (2) by M. P. White, C. P. Band, Canadian Archt., Jan.

THEATRES.—Vittorio Emanuele, Palermo, by C. B. F. Basile, Builder. Jan. 4.—LaFayette Square Opera House, Washington, D. C. (with two interiors), by Wood and Lovel, In. Archt., Jan.

Leading Articles.

3568. The Proper Arrangement of Water Closet and Bath Apartments. Ill. William Paul Gerhard (A discussion of the proper arrangement of the rooms or apartments in which such fixtures are placed in the different classes of buildings). Arch & Build-Jan. 11. Serial. 1st part. 2000 w.

*3581. Kirkstall Abbey. Ill. (Historical and descriptive). Builder-Jan. 4. 6000 w.

*3582. The New Imperial Supreme Law Courts at Leipsic (With the new Houses of Parliament these buildings are said to be the most important structures erected since the foundation of the new Empire twenty-five years ago. (Descriptive and historical). Builder-Jan. 4. 2000 w.

*3583 The New Municipal Theatre at Palermo (Brief history of the building, with drawing of the elevation, a longitudinal section, and two plans). Builder-Jan. 4. 1400 w.

*3584. The Chimney-piece (A finely illustrated article explaining how the chimney-piece came to be regarded as an important part of the interior, and describing some early decorations). Arch, Lond-Jan. 3. 1200 w.

3586. The Avery Memorial Library. J. A. Schweinfurth (An account of the library founded in memory of Henry Ogden Avery, at Columbia College, by his parents. It already numbers about 13,000 volumes). Am Arch-Jan. 11. 3000 w.

3587. Frogner Hovedgaard. K. Monck, in *N. Y. Evening Post* (Some remarks on the architecture of Christiania, with a description of the estate of the American consul). Am Arch-Jan. 11. 2000 w.

3588. The Origin and Styles of Pompeiian

Decoration. Alfredo Melani (The writer divides the Pompeiian decorations substantially into three styles, characterized by their principal aspects, and considers them of Greek or Hellenistic origin). Am Arch–Jan. 11. 3000 w.

3611. Combined Iron and Wood Framing of a Dwelling (A drawing showing a method some times employed in France). Eng Rec–Jan. 11. 500 w.

*3662. Notable Stone Buildings in New York. Barr Ferree (The first part is a finely illustrated description of the Metropolitan Club). Stone–Jan. Serial. 1st part. 1800 w.

†3677. Slow-Burning and Fire proof Construction. Dankmar Adler (Examples of fires in buildings of each class are given, and in part first the "slow-burning" is pronounced by far the inferior system of construction). In Arch–Jan. Serial. 1st part. 3500 w.

3678. Arguments For and Against Tall Buildings (Two letters, published in the *N. Y. Sun*, from George Martin Huss and Ernest Flagg). Arch & Build–Jan. 18 2300 w.

3679. The New Cathedral at Berlin (Descriptive). Am Arch–Jan. 18. 1600 w.

*3687. Eastern Asia; or, China, Corea and Japan. C. T. Mathews (Illustrated description of the architecture of these countries. The first part is a study in China, dealing with its domestic architecture and palaces, pagodas, temples, tombs, etc; followed by a brief account of Corea, which the writer claims was taught by China). Arch Rec–Jan-March. 5000 w.

*3688. A Picturesque Sky-Scraper. Ill. (A complimentary description of the John Wolfe building, New York). Arch Rec–Jan-March. 1700 w.

*3689. Office Methods for Architects (Particulars of the office methods of a firm in Western Ontario with copies of their printed forms for various purposes). Can Arch & Build–Jan. 1000 w.

*3690. Reminiscences of the Architecture of Sicily. A. C. Hutchison (A brief description of the representative buildings of the different styles, and the impressions produced on coming in contact for the first time with the art of the Orient and Occident, where they met on this classic island). Can Arch & Build–Jan. 2000 w.

*3691. Points for Young Contractors. David G. Baxter (Calling attention to the essentials for success in this class of work). Can Arch & Build–Jan. 2500 w.

3697. The Restriction of the Height of Buildings in Cities (Editorial approving the action being taken in this direction, and calling attention to some of the evils arising from very tall buildings in narrow streets). Eng Rec–Jan. 18. 1000 w.

3698. The Construction and Erection of a New York Pier Shed (Illustrated description of the freight and passenger shed for pier No. 13, North River, New York). Eng Rec–Jan. 18. 500 w.

3751. The New Congressional Library (Illustrated historical description) Inv Age–Jan. 2300 w.

3752. A Commercial Museum for New York (A permanent exhibition to be established which will contain a library of information as to the industries, etc., of all countries, with samples also of manufactured goods, both American and foreign. Illustrations of exterior and interior of building are given). Inv Age–Jan. 400 w.

*3758. Architecture: What Is It? J. A. Morris (A paper read at a recent meeting of the Glasgow Arch. Assn). Builder–Jan. 11. 8000 w.

*3816. Modern Theatre Stages. Edwin O. Sachs (Historical account of the movement known by name of "stage reform," which originated in Austria about twenty years ago. The writer proposes to show to what extent modern sciences and methods have already been brought into service, and how the protection of audiences and employés has been attended to. The series will be limited to the explanation of typical examples of stages erected during the last 25 years. The articles will be fully illustrated). Engng–Jan. 17. Serial. 1st part. 3000 w.

*3855. The Persistent Pilaster (Editorial criticism of the use of the pilaster, with its history). Builder–Jan. 18. 2000 w.

*3856. Municipal Buildings. H. T. Hare (Paper read before the Arch. Assn. of England. An epitome of the writer's experience and containing many valuable suggestions. Followed by discussion). Builder–Jan. 18. 8500 w.

3859. Mr. Vanderbilt's Estate, Biltmore (A description of this interesting estate, with two views of the residence, which was designed by the late R. M. Hunt). Sci Am–Feb. 1. 1700 w.

3893. Italian Mosaics—The Cosmatesque Work at Terracina (Illustrated description). Arch & Build–Feb. 1. 800 w.

*3959. Burgos Cathedral (Illustrated description). Builder–Jan. 25. 2200 w.

3960. Architecture in America: A Forecast. John Stewardson (Probably the last contribution that the late John Stewardson made to the literature of architecture). Am Arch–Feb. 1. 3500 w.

*3985. Græco-Phœnician Architecture in Cyprus: With Special Reference to the Origin and Development of the Ionic Volute. Ill. Max Ohnefalsch-Richter (Read at the meeting of the Royal Inst. of British Arch. An account of discoveries in Cyprus and other countries which throw light upon the origin and development of the Ionic capital. Followed by discussion). Jour of Roy Inst of Brit Arch–Dec. 19. 13500 w.

*3986. The Architectural Literature of France: A Brief Historical Sketch and Review (Its source of inspiration and pioneers). Jour Roy Inst of Brit Arch–Jan 2. 7500 w.

3993. Hollow Blocks. A. T. Griffin (Setting forth the advantages of hollow terra cotta building blocks). Brick–Feb. 1800 w.

*4001. Women in the Professions—Architecture. Margaret Mac Naughton, in *The Delineator* (General talk on the way of entering the field, and the course to follow). So Arch–Jan. 2200 w

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Flow of Water in 48-In. Pipes.

A SERIES of valuable experiments were made during 1894 95 on a part of the Sudbury aqueduct which has supplied water to Boston for sixteen years. These experiments were planned to determine what effect the incrustations on the interior of the pipe had on its carrying capacity, and they showed that, after cleaning out the tubercules and incrustations, the discharge increased about thirty per cent. A complete record of these tests is given by Mr. Desmond Fitzgerald in a paper before the American Society of Civil Engineers. The formula which the author chose for his investigations was an exponential formula which "would fit the case of the tuberculated pipe much better, and of the clean pipe somewhat better, than Krutter's formula. The desired formula was obtained by the method of logarithmic homologues described by Prof. Reynolds in the *Proceedings and Transactions* of the Royal Society, London, 1883. The logarithms of I (friction head in feet per foot of pipe) were plotted as abcissas, and the logarithms of v (mean velocity in feet per second) as ordinates, and from drawing straight lines, coinciding as nearly as possible with the plotted points on these logarithmic diagrams, exponents were obtained from which the following formulas are derived:"

For north pipe, cleaned.	$v = 165\, I^{\frac{1}{1.91}}$	$v = 171.3\, I^{\frac{1}{1.9}}$
For north pipe, tuberculated	$v = 99.493\, I^{\frac{1}{2.03}}$	$v = 110.43\, I^{\frac{1}{2}}$
For south pipe, tuberculated.	$v = 105.41\, I^{\frac{1}{2.02}}$	

R (the hydraulic mean depth in feet) is taken as unity in this case, and does not appear. The values in the second column are rounded off and simplified, as shown in the third column. To show how closely these values agree with the determinations of other observers, the author refers as follows to a paper read before the same society by Mr. F. P. Stearns, in 1884: "By the three experiments which Mr. Stearns regarded as trustworthy, the coefficient c in the Chézy formula, $v = c\sqrt{R\, I}$, had values as shown in the second column in the table below for the velocities given in the first column. The corresponding coefficients as determined by our experiments of 1894-95 in the clean pipe (tubercules removed) calculated by the formula $c = 131.88\, v^{0.045}$ (the same value used in the first formula in the preceding table) are given in the third column.

Velocity—ft. per sec.	c—Stearns, 1880.	c—Fitzgerald, 1894-95.
3.738	140.14	139.94
4.965	142.11	141.74
6.195	144.09	143.16

The concluding paragraph is of interest. "The results herewith presented led the author to the conclusion that piezometric gages laid upon the bottom of a pipe, and those screwed into the sides, gave equally accurate results, and that these piezometers, when properly arranged, can be depended upon as certainly as can other hydraulic appliances of precision. The author is particular in calling attention to this fact on account of slurs that have been cast by some hydraulicians upon piezometric observations." This statement is of vital importance. The East Jersey Water Company, following the designs of Mr. Herschel, their engineer, installed a riveted steel water-supply main, 48-in. diam., with 7-ft. sections, for supplying Jersey City with water. The pipe was designed to deliver at a hydraulic slope of 0.002 at least 50,000,000 gals. daily, but in practice it delivered but 35,000,000. The engineer explained the error in design by referring to a similar pipe at Rochester.

N. Y., about which an apparently erroneous report had been issued. This explanation would have been satisfactory, had not he discarded his own experiments, made at Holyoke in 1887, on a pipe with similar joints and giving a coefficient of roughness of 0.016, which, if applied to the Jersey City pipe, would have given a discharge of 32,000,000,—not far from the actual flow. In his report, he discards his own observations, because they did not agree with certain published formulæ, explaining the deviation of his results by saying "that piezometers do not correctly indicate the *h* of the formula" contained in Hamilton's Smith's "Hydraulics." The moral is plain. Mr. Rudolph Hering, in the *Engineering Record* (Jan. 25) and the *Engineering News* (Jan. 23), offers a criticism on the designs of Mr. Herschel, referred to above, in which he says, after explaining the conditions and warning engineers against old formulæ:

"The effect of such small projections upon the velocity in a pipe seems to be even now hardly sufficiently appreciated. D'Arcy & Bazin first called attention to this effect. In order to indicate the great difference of flow in smooth channels and such having small projections, I append the results of some of their carefully-made gagings, selected from among many, so as to correspond fairly well with the case in question, and such correspondence is sufficiently close for the present purpose. The value of the coefficient of roughness (*n*) was of course obtained by the experiment. Applying it to the conduit in question, its discharge is computed for each case. The other gagings mentioned herein are also embodied in this table."

Evidently, if municipal authorities or private corporations are going to continue the construction of water supplies, and engineers to stake their reputation upon the design, it is high time that they should join hands in collecting and recording data which shall be at least accurate.

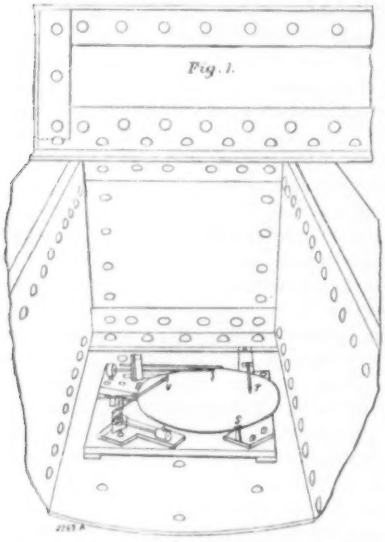
Recording Vibrations in Iron Bridges.

IT is important that a railroad bridge should stand up firmly under a moving train with ordinary conditions, and that no synchronous vibration should occur. It is often difficult to determine by the eye alone whether the latter exists and whether it may not be due to a loose connection which would render the member itself useless, and the adjacent member liable to undue strain. Messrs. Pownall and Milne, in London *Engineering* (Jan. 24), describe some experiments in this direction, made by them on the Rokugo bridge in Japan.

"The instrument which was used in these experiments was a compact and

COMPUTED DISCHARGES FOR A CIRCULAR CONDUIT WITH A HYDRAULIC SLOPE OF 0.002 AND AN EFFECTIVE DIAMETER OF 47¼ INCHES.

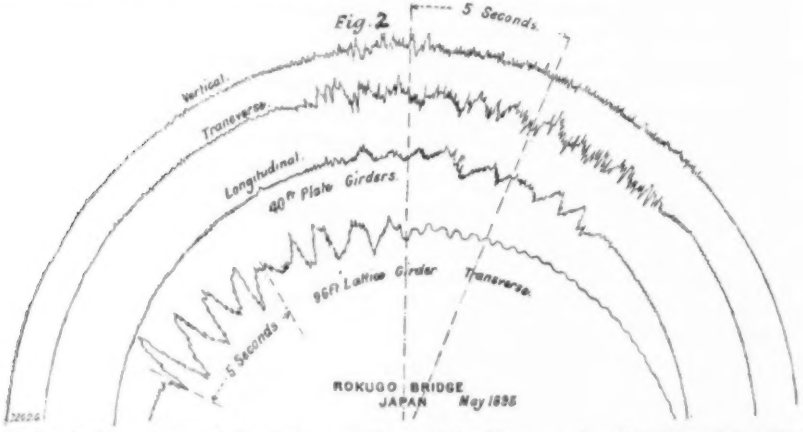
Number. Author.	Description of Wetted Perimeter.	Coefficient of Roughness (*n*), Kutter.	Discharge in Million Gallons per Day.
1. Assumed for E. J. W. Co.'s conduit (1889) ..	Steel, rings about 7 feet long, riveted with lapped joints, thickness of plates one-fourth to three-eighths inch....	.0106	50
2. Stearns (1885).....	New cast-iron pipe, near Boston, very easy curves, coated with asphalt, clean	.0108	49.2
3. Brush (1882-87).....	New cast-iron pipe, in New Jersey, large number of summits, angles and curves, coated with asphalt.....	.0127	41.3
4. D'Arcy & Bazin (1865)	Test channel of neat cement.....	.0103	52
5. D'Arcy & Bazin (1865)	Test channel of planed boards.....	.0118	44.8
6. D'Arcy & Bazin (1865)	Test channel, lined with pebbles three-eighths to seven eighths inch diameter..	.0169	30
7. D'Arcy & Bazin (1865	Test channel, lined with laths 1×⅜ inch, nailed crosswise to current, three-eighths inch apart.....	.0154	33.4
8. D'Arcy & Bazin (1865)	Test channel, lined with laths 2 inches apart.....	.0216	22.9
9. Herschel (1887).....	Wrought-iron flume at Holyoke, rings about 4.5 feet long, riveted, with lapped joints, thickness of plates 0.03 foot	.016	32



portable form of seismograph, which gives, for all practical purposes, absolute measurements of the movements to which it is subjected.

"The horizontal components of motion were recorded by means of two horizontal lever seismographs, so arranged that their writing indices were at right angles to each other. The outer ends of the three writing indices rested on the smoked surface of a glass disc, which could be caused to rotate at a uniform rate by means of clockwork placed beneath it. When these indices are at rest and the disc revolves, three concentric circles are described, but, when the instrument is shaken, the indices move proportionately to the motion they receive, and a succession of ripples or waves are drawn. To determine the rate at which the disc revolves, on which depends the determination of the time taken to describe any particular vibration, or the time occupied by the train passing the point of observation, and other things, at intervals of five seconds a mark is made upon the edge of the disc as it passes the same point. After a diagram has been obtained, the smoked surface is covered with photographer's varnish from which, after drying, a blue print may be obtained. Fig. 1 shows the general arrangement of the apparatus resting on the bottom boom of a 200-ft. lattice girder. In this figure, V is the pointer for vertical motion, L that for longitudinal motion, T that for transverse motion, and S a style that is moved by hand, or electrically, every five seconds to give the necessary time marks. The clockwork is hidden by the disc it actuates."

The results obtained by the use of the above-mentioned seismograph are shown in Fig. 2.



"A glance at the diagrams shows that at least three classes of movement have been noted. First, there is an elastic vibratory motion which precedes a train; secondly, there are forced displacements due to the passing of the locomotive, its

tender, and each of the carriages or wagons, which may be described as somewhat sudden bendings, which take place as each pair of wheels passes the point of observation; and, thirdly, the elastic swing of the bridge, which continues for some time after a train has passed, and which corresponds in character to movements produced by wind. The study of the first type of movement may prove to be only of scientific interest, but that of the second and third types suggest that diagrams of bridge motion may have certain practical values."

Expressed in tabular form, we give the results of six tests, which will repay close study. The high lateral and vertical stiffness of the 200-ft. girders as compared with the 100-ft. girders will be noticed at once.

VIBRATIONS CAUSED BY TRAINS PASSING OVER BRIDGES.

—	Weight of Locomotive.	Number of Carriages or Wagons.	Speed in Miles per Hour.	Time Passing in Seconds.	Maximum Transverse Motion in Millimeters.	Transverse Periods in Seconds.	Maximum Longitudinal Movement of Displacement In dices.	Longitudinal Period	Maximum Vertical Displacement in Millimeters.	Vertical Period.	Nature of Girder.
	tons cwt										ft.
Experiment 1. .	38 8	8 to 12	24	10	25	.47	9	..	4	.06?	100
" 2.	38 8	8 " 12	14 to 20	10	10	.41	4	..	4	.08?	100
" 3.	27 14	8 " 12	18	12	10	..	7	..	7	.08?	40
" 4.	27 17	29	11	37	20	.62	1 to 2	..	4	.33	200
" 5.	27 17	27	20.4	17.2	16	.62	4	.33	3	.33	200
" 6.	28 16	28	16.4	23	12	.62	2	..	2	.33	200

"Not only do the diagrams referred to in this paper show that different classes of girders have very different characters of motion, but they also show that a vibration meter is capable of detecting small differences in the vibrations of two apparently similar girders. They also indicate that, if it is desirable, a meter might be established on a bridge, not only to record the vibrations due to wind or traffic, but also to record the times at which these disturbances took place, the speeds at which trains had passed, and their relative weights."

A Simple Hydraulic Formula.

THE current discussion in the technical press on the Jersey City pipe line fiasco has induced a communication from Mr. E. Sherman Gould in the *Engineering News* (Jan. 30). Speaking of the usual refinements in hydraulic formulæ which consider interior finish, incrustation, and joints, he says:

"Not that these conditions—particularly those of interior surface—are not controlling factors, but simply because it is practically impossible to determine these conditions for any given system of pipes, and still more impossible to predict how long these conditions may continue to exist without undergoing modifications and changes due to time and service. We know as a fact that the delivery of a pipe line must go on diminishing with age, owing to the formation of a greater or less degree of incrustation, not to speak of the probability of leakage gradually being developed. It has appeared to me, therefore that costly disappointments would be avoided by using simpler formulas, containing a more liberal allowance for unknown and unknowable factors.

"In making the calculations some years ago for my little work on hydraulics, I was struck with the fact that the adoption of a reasonable mean co-efficient for rough pipes, or those which had been some years in service, led to the following formulas, which may be said to represent the absolute maximum of simplicity, for the co-efficiency is reduced to unity.

$$Q = \sqrt{D^2 + H} \quad \ldots\ldots\ldots (1)$$

$$D = \sqrt[5]{\frac{Q^2}{H}} \quad \ldots\ldots\ldots (2)$$

Also, approximately:

$$V = \sqrt{D + H + 1.6} \quad \ldots\ldots\ldots (3)$$

In these equations:

Q = cubic feet per second.

D = diameter of pipe in feet.

H = fall per 1,000.

V = feet per second.

Applying this formula to the Jersey City pipe line, we get

$$Q = \sqrt[5]{4^5} + 2 = 45.25 \text{ cu. ft. per sec.,}$$

which is about 84 per cent. of the actual present discharge through the clean, smooth pipe. Fifteen per cent. is a small margin even, for, after cleaning the 48-in. pipe of the Boston pipe line, there was an increased flow of 30 per cent. Applying the formula again, we find that, to discharge 50,000,000 gallons daily, we should require a pipe of diameter

$$D = \sqrt[5]{\frac{77.4^2}{2}} = 5 \text{ ft.}$$

instead of the 4-ft. pipe now in operation.

The Villa Mantle for Protecting River Banks.

AMONG the latest practical protective devices coming to our notice is the brick mattress devised by Signor Giovanni Villa, an Italian engineer. The mattresses used on our Mississippi improvement work are made of timber and brushwood weighted down by stone. The method has given excellent service, as timber will decay but slowly when under water; however, when submerged but part of the time, it is unsatisfactory, as decay soon sets in. The new method is thus described by London *Engineering* (Dec. 27). As shown by the accompanying cut, "this mantle consists of a series of perforated bricks or tiles strung onto zinc or other suitable wires and laid over the bank which is to be protected from scour. The wires prevent the displacement of the tiles by the wash of the stream, and in a very short time the silt deposited from the river, and the growth of vegetation where possible, render the mantle an integral part of the bank. The system has already been tested practically on a fairly extensive scale in different parts of Italy. Thus a strip of the bank of the river Olona, near Milan, nearly one thousand yards in length, was dealt with in this way five years ago, and on a recent examination proved to be in excellent condition. Similar results have been obtained in the case of protection works carried out on the banks of other streams. In particular, the French government have adopted it in some works at Bougival on the Upper Seine. The cost is said to be very low, and the work can be executed very rapidly, as much as one hundred and sixty-five yards being laid per day by one machine."

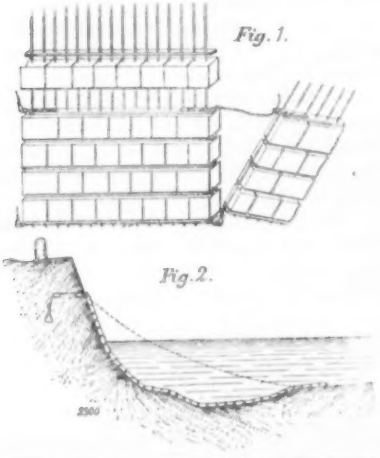
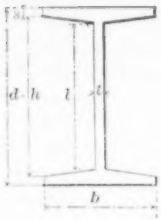


FIG. 1. DETAIL. FIG. 2. MANTLE IN SERVICE.

Standard Structural Shapes.

THE following standards, coming from authorities so eminent, are worth the consideration and attention of all engineers. *The Iron Age* (Jan. 9) says:

"As many of our readers are doubtless aware, a movement has been on foot for some time to standardize structural shapes. The Association of American Steel Manufacturers put the matter in the hands of a committee, consisting of Chas. L. Taylor of Carnegie, Percival Roberts, Jr., of Pencoyd, and Chas. S. Price of Cambria. A very great amount of correspondence has been going on with the different manufacturers, giving their views, and, as a result of this correspondence, a proposed standard for I-beams and channels suggested by the above committee has been formulated. This is shown in the accompanying drawings and tables.



Formula for area:

$$\text{Area} = t\,d + 2s\,(b - t) + \frac{(b-t)^2}{100}\,16\tfrac{2}{3}.$$

Formula for weight:
Weight per foot = area × 3.4

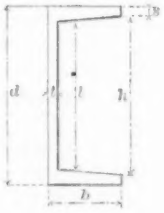
Formula for moment of resistance:

$$R = \frac{2I}{d} \qquad \text{Batter} = r = \frac{h-l}{2\,(b-t)}$$

$$I = \frac{1}{12}\,[b\,d^3 - \frac{1}{8\,r}\,(h^4 - l^4)]$$

I = Moment of inertia, neutral axis parallel to flange.

s = thickness of web
= t for all except
For 20″ I s = 0.55″.
For 24″ I s = 0.90″.



Formula for area:

$$\text{Area} = t\,d + 2s\,(b - t) + \frac{(b-t)^2}{200}\,16\tfrac{2}{3}$$

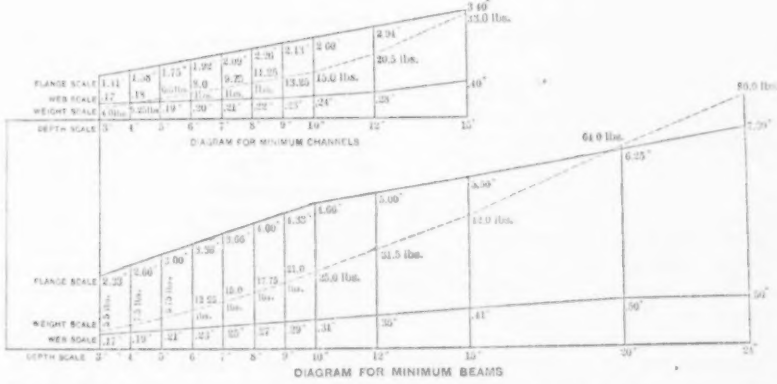
Formula for weight:
Weight per foot = area × 3.4

Formula for moment of resistance:

$$R = \frac{2I}{d} \qquad \text{Batter} = r = \frac{h-l}{b-t}$$

$$I = \frac{1}{12}\,[b\,d^3 - \frac{1}{4\,r}\,(h^4 - l^4)]$$

I = moment of inertia, neutral axis parallel to flange.



Beams and Channels to be cut to lengths with extreme variation not exceeding 1½″. Any cutting to less variation will be charged 1-10 cent per pound extra.

PROPOSED STANDARD STRUCTURAL SHAPES.

Proposed Standard Channels.*

Depth.	Intermediate weights between sizes.	Max. wt.	Min. area.
In.		lbs.	Sq in.
15..	45 pounds, then vary by 5 pounds..	55.0	9.9
12..	25 pounds, then vary by 5 pounds	45.0	6.0
10..	Vary by 5 pounds	33.0	4.5
9..	15 pounds, then vary by 5 pounds.	25.0	3.9
8..	Vary by 2½ pounds	21.25	3.4
7..	Vary by 2½ pounds	19.75	2.9
6..	Vary by 2½ pounds	15.5	2.4
5..	Vary by 2½ pounds	11.5	2.0
4..	Vary by 1 pound	7.25	1.6
3..	Vary by 1 pound	6.40	1.2

Proposed Standard Beams.*

Depth.	Intermediate weights between sizes.	Max. wt.	Min. area.
In.		lb.	Sq. in
24..	Vary by 5 pounds	100.0	29.3
20..	70 pounds, then vary by 5 pounds	100.0	19 3
15..	45 pounds, then vary by 5 pounds	100 0	12.5
12	35 pounds, then vary by 5 pounds	75 0	9.3
10..	Vary by 5 pounds	40.0	7.4
9..	25 pounds, then vary by 5 pounds	75 0	6.3
8	Vary by 2½ pounds	25.25	5.2
7..	Vary by 2½ pounds	27.0	4.4
6	Vary by 2½ pounds	17 25	3.6
5..	Vary by 2½ pounds	14.75	2 9
4	Vary by 1 pound	10.5	2 2
3..	Vary by 1 pound	7 5	1.6

* For other dimensions see diagrams.

"As a basis a 6-inch channel was used, and a 6-inch beam. Mr. Taylor advises us that the minimum weight and sizes may be changed to some extent before they are finally adopted. In rolling 12-inch beams, Mr. Taylor states that they roll from 31½ pounds up to 40 pounds without changing rolls; from 40 pounds up to 55 pounds, which is the maximum weight, they change the rolls, and these are special sections. This applies also on 15-inch beams from 60 to 80 pounds, being special sections, and on 26-inch beams from 80 to 100 pounds. At the present time they are rolling 56 different sizes of angles. It is proposed to very materially reduce this number, and it is altogether likely that angles will be rolled in the following sizes:

Equal legs in's.....	6×6	4×4	3½×3½	3×3	2½×2½
Unequal legs in's	6×4	5×3½	5 ×3	4×3	3½×3
Equal legs in's.....	2×2	1½×1½	1×1	¾×¾	
Unequal legs, in's...	3×2½	2½×2	. ....	.. ..	

"It is quite likely that two or three other sizes will be added before they have been officially adopted."

Maintenance of Highways.

AT a meeting of the Improvement Society of East Orange Township, N. J., Mr. William S. Bagot read a paper, pointing out certain improvements possible in the organization and methods of the highways department of the township.

After showing that the moneys expended ($18,000) on streets and roads were entirely inadequate, and that the commissioners were hampered by their political appointers, he suggests (*Engineering News*, Feb. 6):

"In my opinion the best results would be obtained by placing the department in the hands of a single commissioner (not an appointee of the township committee), who would be an energetic man and an engineer of experience, giving him full power and means to carry out the proper purposes of his office, independently and free from interference, and then holding him strictly accountable for his official acts. He should have an assistant (at about $1,000 salary a year) to give lines, grades, etc., on street and sewer work, and an assistant in charge of road repairs and street-cleaning; also other helpers, instrument men, etc., as occasion may demand, but not regularly employed unless the amount of the work warrants the expense. The laborers should be hired directly, and organized on the basis of a limited block system, with a central working force to cover territory not included in the block system. (This system was described in the *Engineering News*, Dec. 6, 1894.) In East Orange there should be a block man to each two-thirds of a mile of road, which piece of road he could keep clean and in order, making light repairs, restore the surface after it has been broken by excavation for water or gas pipes, etc. Each man should be provided with a barrow or push-cart, short square shovel, street broom, large hoe, rake, pick, and iron tamper, and should wear a suitable uniform. There should be fifteen of these men, and the equipment would cost about $10 per man."

In the present system there is neither regularity or uniformity. Curbs are often six inches higher than necessary; roads are found both flat and with excessive crowns; street-sprinkling, when left to the judgment of the local driver, often damages the roadway. These evils are some of those which necessarily follow makeshift methods, and certainly it is of importance to municipal and township authorities that their moneys be expended in such a way as to give satisfactory results.

DUTIES OF THE ENGINEER TO THE PUBLIC is the last clause of a code of engineering ethics drawn up and adopted by the Canadian Society of Civil Engineers a year ago, and published in the *Engineering News* (Feb. 13). The clause referred to specifies that: "The civil engineer whose advice is sought in respect to the usefulness, practicability and cost of a work should, before expressing his opinion, obtain reliable information on all points involved in the matter submitted to his judgment, including the probable paying capacity of the contemplated undertaking. He must be cautious how he recommends

large preliminary outlay; should avoid connecting himself with schemes or projects of merely speculative character, always bearing in mind that his professional reputation will be to a great extent judged by the inherent merits and commercial value of the undertakings with which his name may come to be associated."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

3609. A Forty-Foot Concrete Arch Highway Bridge. Ill. (Said to be the first concrete arch built of the size in the United States, being 40 ft. span, and 7 ft. rise, and built entirely of concrete). Eng Rec–Jan. 11. 1500 w.

3811. Harlem River Drawbridge (General description, elevation, plans and diagrams, strain sheet, and truss details). Eng Rec–Jan. 25. Serial. 1st part. 1400 w.

*3830. The Albert Railway Bridge at Indooroopilly, Queensland. Ill. (The method of erection of this two span bridge is described; each span is 340 ft. long and 41½ ft. deep at centre of curved top boom). Eng. Lond–Jan. 17. 2000 w.

*3946. Barker's Bridge Flooring (It consists of troughs riveted together. The method of construction is described and illustrated). Eng, Lond–Jan. 24. 3000 w.

*3951. On the Vibrations Caused by Trains Passing Over Iron Bridges. C. A. W. Pownall and John Milne (A series of experiments, illustrated by sketches of apparatus used and the curves recorded, to determine the transverse, longitudinal and vertical amplitude of vibration of bridges under moving loads). Engng–Jan. 24. 4500 w.

*3996 Movable Bridges in European and American Cities (A report by George W. Rafter to the N. Y. state engineer on lift bridges, with a view to their application to the Erie Canal and city of Rochester. The article is well illustrated and is a valuable contribution). Pav & Mun Eng–Feb. 1800 w.

4019. A Concrete Arch of 40-ft. Span at Belleville, Ill. (Description of construction, illustrated by sections of arch and abutments. The bridge was tested by a load of 150 lbs. per sq. ft. The article gives the proportions of the ingredients of the concrete for the several parts of the bridge). Eng News–Feb. 6. 1300 w.

4025. Quantities of Paint Required for Bridges of Various Spans. C. E. Fowler (Quantity and cost of the various paints required for highway and railroad bridges for spans of 20 to 300 ft., varying by 20 ft. difference). Eng News–Feb. 6. 300 w.

4029. The New Draw Bridge Over Frankford Creek, Philadelphia. Inset (An electrically operated bridge illustrated by detailed drawings). R R Gaz–Feb. 7. 1500 w.

Canals, Rivers and Harbors.

*3663. The Chicago Drainage Canal (A description of some of the methods of excavation, illustrated by half tone cuts). Stone–Jan. 1500 w.

3726. The Chicago Canal, and Some Sanitary Problems Connected Therewith. P. H. Bryce An address before the Engineering Society of the School of Practical Science, Toronto). Can Eng–Jan. 2000 w.

3756.—$1.50. Bank Revetment on the Lower Mississippi. H. St. L. Coppée (The various methods of channel protection and divergence are explained, with illustrated descriptions of the mattresses, spurs, anchors, barges, and other devices used. The article is exhaustive and detailed). Trans Am Soc of Civ Engs–Jan. 27500 w.

3883. The Levees of the Mississippi River. William Starling (A valuable and exhaustive article on the construction, care of, and repair of river embankments. Inset). Engng News–Jan. 30. 15500 w.

†3906. Commerce and Deep Waterways. Ill. Lewis M. Haupt (An extremely interesting paper on the transportation losses due to low water, with especial reference to the Ohio River near Pittsburg). Jour Fr Inst–Feb. Serial. 1st part. 6500 w.

4026. The Present Aspect of the Mississippi River Navigation Improvement. J. B. Johnson (A review of the organization and plan of work of the Mississippi River Commission and a note on the efficiency of the new 600 cu. yd. per hour suction dredge). Eng News–Feb. 6. 2000 w.

Hydraulics.

3755.—$1.50. Flow of Water in 48 in Pipes. Desmond Fitzgerald (Over two cart loads of tubercles, which incrusted the interior of the pipe were removed, resulting in an increased flow of 30%. Flash light photographic views are given of the interior of the pipe, and the method of measuring velocities, etc., is described. The actual observations are given in tabulated form). Am Soc of Civ Engs–Jan. 5000 w.

†3773. Improved Water Discharge Recorder It is intended to keep a graphic record of the gallons flowing over a weir, by means of an automatic water head register). Ind & East Eng–Dec 21. 1500 w.

3791. Tunnel Sections of the Nashua Aqueduct for the Metropolitan Water Supply. Ill. (Copious extracts from the specifications). Eng News–Jan. 23. 2500 w.

3794. The Capacity of the East Jersey Water Company's Conduit. Rudolph Hering (Valuable criticism upon methods of measuring the flow of water in pipes, noting especially the effect of roughness). Eng News–Jan. 23. 1800 w.

We supply copies of these articles. See Introductory.

*3828. Failure of the Great Dam of Bouzey (General remarks on this and other dam failures). Eng, Lond–Jan. 17. 3600 w.

*3831. Observations on the Flow of Water in the New Aqueduct from Loch Katrine: Glasgow Corporation Waterworks. Alexander Fairlie Bruce. (The conduits are concrete lined for half their length and have a coefficient of friction of 0.0121 to 0.0125. Complete data accompany report). Eng, Lond–Jan. 17. 900 w.

3885. Curved Masonry Dam for the Water-Works of the City of Remscheid, Germany (Abstracted from a paper by Prof. O. Tutze in the Jour. of the Soc. of German Engs., by O. J. Marstrand. The dam is 13-ft. thick at the crest, 49 ft. thick at the base, 82 ft. high and curved up stream with a radius of 410 ft.) Engng News–Jan. 30. 1500 w.

*4075. Longevity of Timber for Dams. E. R. Beardsley (The writer demonstrates the superior advantage of pine over oak timber for subaqueous structures acted on by running water, and says that the method of building should be determined largely by the kind of timber available). Am Miller–Feb. 1000 w.

Irrigation

4021. The Bear River Irrigation System, Utah. W. P. Hardesty (The article contains full details of the work and is illustrated by cuts and sections of the dam and tunnel). Eng News–Feb. 6. Serial. 1st part. 3000 w.

Miscellany.

†3676. The Relation Between Tests and Use of Portland Cements. W. S. MacHarg (The detail of improvement is discussed, to make it clear that it is positive and permanent, and for the purpose of showing that economy may be safely practiced with the present quality of Portland cement). In Arch–Jan. 4500 w.

*3750. Notes on Cement Testing. H. M. Norris (Explicit instructions as to the best methods of testing cements and mortars. The usual tensile strength, or cohesion test, is regarded as least important). Digest of Phys. Tests–Jan. 2200 w.

3767. The Sewers of Paris—An Inverted Siphon under the Seine (The sewer is lined with sheet iron and consists of a shaft at one bank connecting with a tunnel under the river, which rises gradually into the sewer on the other bank). Sci Am Sup–Jan. 25. 700 w.

3780. Re-opening a Canal (A prospectus has been issued by the Lake Drummond Canal & Water Co. for the reconstruction of the old, and now disused, Dismal Swamp Canal). Mfrs Rec–Jan. 24. 3500 w.

3790. The Water-Works of Curazoa (A system of concessions by which one man furnishes the town with electric light, water, ice, coal, and has built a pontoon bridge, which is illustrated.) Eng News–Jan. 23. 400 w.

3792. Effect of the Fineness of Sand upon the Strength of Cement Mortar (Tests which indicate that below 40 meshes there is no preference in sands used; the coarser grades are the better above 40 mesh; the condition of the surface of sand particles largely affects their efficiency. The results of the tests are given in a diagram). Eng News–Jan. 23. 1200 w.

3793. A New Method of Chaining Slopes. J. C. Isaac Leskard (A method of measuring horizontal distances on a slope without subsequent reduction, by the use of a protractor attachment to the chain). Eng News–Jan. 23. 700 w.

*3817. The Emptying of the Merjelen Glacier-Lake. C. S. Du Riche Preller (The water banking up against the side of a glacier formed a lake which occasionally overflowed and flooded the Rhone valley. This danger was mitigated by running a drainage tunnel into the bottom of the lake). Engng–Jan. 17. 1400 w.

3958. The Manufacture and Uses of Wire Rope. F. H. Hopkins (General remarks followed by the description of a sand handling cable plant at Niagara Falls). Can Min Rev–Jan. 2800 w.

3994. The Utility of Drain Tile. P. S. Kempton (A paper read before the Ill. Clay Workers Assn. on the beneficial effects of subsoil drainage on agricultural lands). Brick–Feb. 2800 w.

†3998. Paint as a Protection for Iron. E. A. Custer and F. P. Smith, with Discussion (The principal requisites are given as adhesion, non-corrosion, toughness, elasticity, and it must be water proof). Pro Eng's Club of Phila–Jan. 7500 w.

†3999. Notable Engineering Achievements in the Great Lake Region. John Birkinbine (Among other notable features described are the 800 × 100 ft. Sault Ste Marie Lock, the ore docks, the Chicago drainage canal, and the 3000-ft. Marquette Breakwater). Pro of Eng's Club of Phila–Jan. 5000 w.

4008. Burning of Clay. Thomas Townsley (A practical article giving the results of the author's experience). Clay Rec–Jan. 29. 3000 w.

4020. The Better Maintenance of Highways in the Township of East Orange, N. J. William S. Bacot (The article contains some valuable suggestions on the organization required to maintain good roads). Eng News–Feb. 6. 1100 w.

4022. A Dipper Dredge for Digging Phosphate Rock (Illustrated Description of a 1 cu. yd. dipper dredge, handling 50 to 70 cu. yds. per hour). Eng News–Feb. 6. 400 w.

4027. Moving a Stone Church Building in Chicago (The building weighed 6652 tons, and was 225 ft. high to top of spire. It was removed 510 ft. successfully). Eng News–Feb. 6. 1200 w.

4030. A Case of Inadequate Engineering (The results of an investigation into the work on the driveway along the Harlem River, pointing out several features open to criticism). R R Gaz–Feb. 7. 1800 w.

4054. Sixty-Ton Bucyrus Steam-Shovel. Ill. (An unusually heavily constructed dredge used in hard pan and iron ore. The thrust is derived from two strong engines on the boom itself). Ir Tr Rev–Feb. 6. 500 w.

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Lead vs. Iron Pipes in Plumbing.

A SYMPOSIUM of correspondence upon this subject appears in *Domestic Engineering* for January. The letters are mostly from practical men, who have had opportunity to judge the results of the growing use of wrought-iron pipes instead of lead, one of the chief reasons for which is the modern tall building, in the main stacks of which the use of lead pipe is impossible, wrought iron being the only material available for the purpose.

The longest and most important of the communications is one from Mr. C. J. Johnson, of Chicago; and, as the other shorter letters concur, in the main, with his opinion, an abstract of his views will present the general tone of disapproval of iron as a substitute for lead water pipes in buildings of moderate heights.

In residence buildings, and in business buildings of moderate size, where fire-proofing is not a part of the specifications, this necessity does not exist, and the practice of introducing wrought-iron pipe in the plumbing of these buildings certainly does not show good judgment. Lead is the most suitable material for this class of work, being pliable and susceptible of being bent and stayed at any angle to the main run; and, being of uniform bore, it presents the minimum resistance to flow, and minimum friction. Wrought-iron pipe is not of uniform bore. Its fittings are made on angles of forty-five or ninety degrees, and a fall which will allow iron pipes to be readily emptied when water is shut off is difficult of attainment. All connections with the plumbing fixtures must be made on angles of ninety degrees, leaving the lateral runs horizontal. As all fittings used on wrought-iron pipe are larger in diameter than the pipe itself, it can be readily seen that, to thoroughly empty a system of wrought-iron pipe throughout a building, is an absolute impossibility. The water thus collected in the fittings will attack and dissolve the iron exposed, and the moisture circulating through the pipes when partially empty will cause rapid oxidation of the interior surface, all of which, when water is again turned on, will be discharged into the plumbing fixtures, making a most unsightly appearance. The glazed surface of water-closets, basins, porcelain tubes, etc., will "craze" when exposed to light or to rapid changes of temperature, even for a short time, and the iron solution will soon find its way into the fissures thus made, and forever ruin the future appearance of such fixtures.

In large fire-proof buildings, where main supplies and laterals are iron and connections to fixtures are lead, this destruction of earthenware can readily be seen, even though but a small quantity of soluble salts of iron can find its way into the fixtures. In a residence building, where the water is often turned off for protection and safety during cold weather, there is no escape from this nuisance.

The destruction is extended to all washable apparel, to say nothing of articles of food and drink, many of which may be changed in their appearance and composition through chemical reaction with the iron.

Galvanized pipe, from a chemical point of view, is far more dangerous than black iron pipe. The ends of the pipe and the interior threaded part of the fitting exposed are not galvanized; hence the contamination of iron cannot be entirely done away with. Another difficulty appears, which is far more serious than the contamination of the water with salts of iron. Zinc and iron are a strong "voltaic couple," and the zinc on the inner surface of the pipes is always more or less rapidly destroyed at the expense of the iron, producing soluble salts of zinc, which are poisonous. All waters that are palatable contain carbolic acid, and many contain chlorids or sulphates. Formation of soluble salts of zinc results. Many cases of

acute poisoning have resulted from drawing hot water from a galvanized range boiler in the kitchen, and using it in making tea or coffee or other articles of food and drink; and many a family physician has been puzzled to know the cause of such ailment, erroneously ascribing it to zinc chlorid used as soldering-flux on fruit cans, without suspecting the real cause.

Lead pipes quickly become coated upon the interior, and then become perfectly innocuous, whereas the oxid formed on the interior of an iron pipe is not perfectly adherent, as is shown by the discoloration of water that has stood for a little time in an iron vessel. When the increased cost of labor in putting in iron pipes is taken into account, the total cost of iron pipes is seen to be so nearly up to that of lead that the greater durability of the lead renders it cheaper in the end; it is altogether a false economy to make such a substitution in any case wherein lead pipes can be used.

Bacteria in Water from Deep Wells.

IT has been a wide-spread popular opinion that the purity of water obtained from deep wells, especially from deep wells of the kind known as driven wells, might be depended upon. Of late, however, there has arisen a doubt of the accuracy of this belief, and scientific investigation has now shown it to be erroneous. In this department for February a case of sewage contamination of one of these wells was described, and examination of waters from a considerable number of springs and deep wells by the distinguished bacteriologist of the Massachusetts State board of health has now shown that bacteria are present in water taken not only from springs and open wells, but from carefully-guarded wells of quite extraordinary depth.

We find in the *Sanitary Record* (Jan. 17) an account of investigations instituted by the board, and carried out by M. W. Sedgwick, Ph. D., biologist of the board, and M. S. C. Prescott, S. B., reprinted from the twenty-sixth annual report. The results of the investigations conclusively prove that Sternberg, Abott, and other high authorities were in error in believing waters from deep sources to be free from bacteria. Frankland, in his celebrated work, "Micro-organisms in Water," evidently had doubts, but his investigations led him to believe that such waters, although, perhaps, not wholly free from micro-organisms, possessed a "high degree of bacterial purity."

But even this belief must be abandoned, in view of results obtained in the recent examinations, which included water from springs, open wells, and tubular wells.

We present in this review a few typical examples of results from each of these sources. A series of springs in a country district of southern New Hampshire were examined under conditions and with results as follows:

Springs. No. 1.—Situated in a field on edge of meadow. Water comes up through a stratum of clay. Rate, several barrels per hour. Water, clear and colorless. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, on gelatine, 252,—258; on glycerine agar, 143,—167.

"Open spring No. 3.—Situated in meadow at base of a wooded hill 400 ft. high. No habitation within one-half mile. Other conditions similar to those in No. 2. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, gelatine, 92,—105; glycerine agar, 72,—79.

"Open spring No. 5—Open land, near top of a hill used in summer for pasture. Soil, gravelly. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, gelatine, 193,—218; glycerine agar 203.—217.

"Open spring No. 6.—Low land pasture, surrounded by shrubs and trees. No buildings anywhere near. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, gelatine, 100,—43; glycerine agar, 72,—36.

"Open Well.—Close to roadside. Sandy soil. Depth, about 15 ft. Operates by bucket. Buildings, 5 rods away. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, gelatine, 509,—525; glycerine agar, 204,—228.

"Open Well No. 2.—On hill top. Sandy soil. Depth, about 30 ft. Operates by bucket. House two rods away. Date of

analysis, January 2, 1895. Bacteria per cubic centimeter, gelatine 248,—190; glycerine agar, 140.

"Open Well No. 3.—Near house. Conditions not so favorable. Depth, 15 ft. Bacteria per cubic centimeter, gelatine, 602,—560; glycerine agar, 469.

"Open Well No. 4.—On hill top. Near house, but yet favorably situated. Soil, sandy and gravelly. Date of analysis, January 2, 1895. Bacteria per cubic centimeter, gelatine, 335, — 332; glycerine agar, 229.

"Spring Waters on Sale.—These were taken from a freshly-opened carboy. Sample No. 1, gelatine, 223,—261; glycerine agar, 207,—197. Sample No. 2 (one day later), gelatine, 165,—157; glycerine agar, 166,—157.

"Driven Wells. — A sample from a driven well in Cambridge, depth 193 ft., in rather gravelly soil, gave, on analysis (in duplicate), 269 and 254 bacteria per cubic centimeter.

"No. 2.—A sample from a well used for a private supply, and operated by a hand pump, gave 30 bacteria per cubic centimeter. In this case the sample was taken after several minutes of continuous pumping. The depth of this well is about 100 ft., and the soil sandy and more compact than in the previous case.

"No. 3.—Depth, 454 ft. Bacteria per cubic centimeter, 206,—214.

"No. 4.—Depth. 254 ft, Bacteria per cubic centimeter, 150,—135.

"No. 5.—Driven wells at Lowell; part of the city supply. (Petcock on pump, December 21, 1894.) Bacterial analysis gave, with gelatine, 228 bacteria per cubic centimeter, with gelatine agar, 178.

"No. 6.—Cambridgeport. Driven well; depth, 198 ft.; diameter, 8 in. In a thickly-settled, level region, not more than 500 yards from Charles river estuary. Various samples from this well have been tested. Samples taken from pipe leading to tank. (*a*) bacteria per cubic centimeter, 116; (*b*) bacteria per cubic centimeter, 192,—193; (*c*) bacteria per cubic centimeter, 262,—258.

"No. 12.—Well on Second Street, south Boston. Depth, 200 ft. From description of engineer it appears that, while the pipe extends only to a depth of a little more than 200 ft., the well was originally bored to a depth of over 1,200 ft. Bacteria per cubic centimeter, 525.

"It is difficult to find deep wells in uninhabited or country districts, and our results are all derived from populous areas. It is possible that other results might be obtained from wells driven in uninhabited regions.

"It is plain, however, that water absolutely free from bacteria is not ordinarily obtained from even deep wells, and that many deep wells contain as numerous bacteria as are found in many surface waters."

Water-Closets and Baths.

AN abstract of a paper by Wm. Paul Gerhardt, in *Architecture and Building* (Jan. 11), will be useful to readers contemplating the erection of residences, as giving hints upon important practical points neglect of which much detracts from the convenience and sanitation of homes.

The following are some of the cardinal requirements of a well-appointed bath-room. It should be conveniently located; it must be capable of being well heated in winter time; and it should have perfect ventilation at all times, but also be free from draughts, which involve danger of catching cold during or after bathing.

Its walls and floors should be, not only sound-proof, but also protected against dampness, steam vapor, and water. It should be well lighted and comfortably furnished. Its dimensions should be such that the bath-room should not seem cramped, or be rendered uncomfortable by the vapor of hot water. The plumbing fixtures should be well arranged and well grouped, and all plumbing, and the supply pipes in particular, should be protected against exposure to frost.

The apartment should be entirely safe from a sanitary point of view,— *i. e.*, all entrance of sewer air must be carefully guarded against; and, last but not least, the whole room must be so arranged as to be easily kept clean.

Bath-rooms should be located on the upper or bed-room floors of a house, at a

point as accessible as possible to the various bed-rooms, though not too prominent.

In the smaller houses there is generally but one bath-room, which must be conveniently reached from all the chambers. A single bath-room for ordinary-sized houses is quite sufficient, particularly where the water-closet is in a separate apartment.

Larger houses have several bath-rooms, —one on each of the bed-room floors, or several bath-rooms on one floor. In the largest mansions of the rich each bed-room suite often has a bath-room attached to it, as the owner's fancy or purse may dictate.

An undue multiplication of fixtures, besides leading to other complications, may require a larger supply of hot water than an ordinary kitchen boiler can supply.

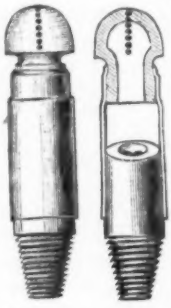
On the top or attic floor provision is often made for a servants' bath-room. A servants' bath should never be omitted, except in the smallest houses. Sometimes it may be more conveniently arranged in the basement or the laundry, or even in an alcove of the kitchen, where hot water can easily be had. This latter is an essential condition, for it is a well known fact that servants will not use a bath-tub with only a cold-water faucet, necessitating the carrying of the hot water for a bath in pails. We should encourage in our domestics the maintenance of cleanliness, as well as provide for their comfort and health, and nothing will tend more surely to secure this than the provision of a simple bath for the use of the servants. The family bath-room should be so located in the plan of the house that it may be quickly reached from the bedrooms without the necessity of crossing long halls or corridors, which, being often insufficiently heated, expose persons to the danger of catching cold. The bath-room may be located in the rear hall-room of the main house, or else in the middle of the house, or, finally, in an extension.

The objectionable plan of placing a water-closet in a bath-room is often seen, even in American houses of a pretentious character. Both sanitary and esthetical reasons demand that they should be separate. Mr. Gerhardt insists that this separation may, in most cases, be carried out by skilful planning, even in small dwellings. A bath and a water-closet have, as a matter of fact, nothing in common, except the soil pipe, with which, according to the best American plumbing practice and contrary to the English practice, both may be safely connected.

A New Gas Burner.

A NEW gas-burner, much extolled for its increase of illuminating power, is described in *Journal of Gas Lighting* (Dec. 20).

The device is a cap burner; but, instead of the ordinary continuous slit, it has a series of small holes, arranged as shown in the figure. It is scarcely comprehensible that this slight difference should make a difference of 233 per cent. in the illuminating power in a burner consuming 3.1 cubic feet of gas per hour; yet this gain is alleged on no less an authority than M. H. Leicester Greville, the chemist of a large gas company in England, and a frequent contributor to the current literature of the gas industry.



THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

Heating and Ventilation.

3612. Heating Two Blocks of Flat Houses from One Boiler Plant (Description with plans). Eng Rec-Jan. 11. 700 w.

*3693. A New System. Leicester Allen (To compete with steam or hot water by forced circulation of hot air). Dom Engng-Jan. 16. 0 w.

*3694 Heat Regulation. Fred W. Powers (In a blast apparatus applied to a hot air furnace). Dom Engng-Jan. 600 w.

*3695. Blast Heating. George D. Hoffman

We supply copies of these articles. See introductory.

(Application of the new system. Illustrated detailed description). Dom Engng–Jan. 900 w.

*3696. Electricity vs. Hot Air (Some considerations on whether electricity will supplant hot air, by a practical furnace man). Dom Engng–Jan. 1000 w.

3795. Comparison of the Methods in Common Use for Driving Fans. William G. Snow (Considered with reference to first cost, expense of running and adaptability). Heat & Ven–Jan. 15. 2500 w.

3807. Forced Blast Warming with Furnaces. George W. Kramer (An able discussion of a method of warming and ventilating which appears to be coming into favor. It is a combination of forced circulation with warm air furnace heating). Met Work–Jan. 25. 4000 w.

3812. Hot-Water Heating in a St. Louis Residence (Detailed illustrated description of hot-water heating plant—closed system). Eng Rec–Jan. 25. 2800 w.

†3888. Expired Air and Problems of Ventilation (Important contradictions of certain accepted views. The injurious effects of expired air are attributed almost wholly to increase of carbonic acid and decrease of oxygen. Doubt is thus thrown upon advanced theories of ventilation. These views seem likely to arouse discussion). Pop Sci M–Feb. 900 w.

3889. The Heating and Lighting of the Philadelphia Bourse (Illustrated detailed description). Eng Rec–Feb. 1. 3000 w.

3905. The Fan and Furnace System of Heating and Ventilation. Walter B. Snow (The system is claimed not to be new, as some have supposed. An instance of a successfully working apparatus of this kind, as erected in the mansion and greenhouses of Baron Hugel, at Schonbrunn, Germany, 45 years ago is given, and it is also stated to have been used for heating large factories in England about the same time. The introduction of small cheap motors now promises to greatly extend the use of the system). Met Work–Feb. 1. 1000 w.

3908. The Incandescent Fire Frame. How to Burn Coke (Describes the "incandescent fire frame," whereby it is claimed much more satisfactory results are obtained than by the more ordinary grates, etc.). Am Gas Lgt Jour–Feb. 3. 800 w.

3969. Electric Heating. W. S. Hadaway, Jr. (Electric heating is treated in this paper more particularly with reference to house heating, car heating, &c., than with reference to its technical side as a branch of electrical engineering, although the latter is not ignored. It is an exhaustive dissertation upon the subject, by an entirely competent author, and gives a full outline of progress to date, while it also in some measure forecasts the future of the art). Heat & Ven–Feb. 6000 w.

3970. Heating and Ventilating of Large Churches. Henry B. Prather (Paper read before the Am. Soc. of Heat & Ven. Engs. How to proceed from beginning to end—architect and heating engineer co-operating—in order to achieve marked success in heating and ventilating churches. Causes of failure are stated, and remedies for them suggested. A good paper, with discussion). Heat & Ven–Feb. 3500 w.

3971. Screwed Fittings for High Pressure. Hugh J. Barron (Paper read before the Am. Soc. of Heat & Ven. Engs. A practical paper in which the superiority of forged fittings over cast fittings is urged. Discussion). Heat & Ven–Feb. 900 w.

3972. Methods of Insulating Underground Systems of Steam Piping. R. C. Carpenter (Read before the Soc. of Heat & Ven Engs. Results of experience, with diagrams showing loss of heat from pipes under different conditions. Discussion). Heat & Ven–Feb. 3500 w.

3973. Forced Blast Warming with Furnaces. George W. Kramer (Read before the Am. Soc. of Heat & Ven Engs. An illustrated paper dealing with both the theoretical and practical principles involved in this system of heating, with examples of its successful application. Discussion). Heat & Ven–Feb. 5000 w.

3975. The Cooling of Closed Rooms. Hermann Eisert (Read before the Am. Soc. of Heat & Ven. Engs. Cooling rooms is treated as negative heating, exterior things being heated by heat abstracted from the enclosure. Equations for positive heating apply to negative heating when signs are changed. A study in artificial refrigeration. Discussion). Heat & Ven–Feb. 6000 w.

4014. Operating a Steam-Heating Plant. W. H. Wakeman (The case of a plant where exhaust steam is used under 1 lb. pressure, in connection with live steam coils, one supplementing the other). Am Mach–Feb. 6. 1600 w.

4039. Hot Blast Heating System in a Boston Church (Illustrated description of an interesting installment. A good study in this system of heating. The air is taken in at an altitude of fifty feet to avoid the introduction of dust). Eng Rec–Feb. 8. 800 w.

Plumbing and Gas Fitting.

*3692. Lead vs. Iron (Opinions of those who are well qualified by knowledge to speak. All decry the growing substitution of iron for lead pipe in plumbing). Dom Engng–Jan. 2400 w.

3701. Plumbing in the Carnegie Building (Illustrated general description of the water-supply system, pump and tank connections). Eng Rec–Jan. 18. 1400 w.

Miscellany.

†3562. A Practical Point in the Use of Disinfectants and Antiseptics. A. G. Young (This article demonstrates that comparatively inefficient antiseptics may be made active and efficient by applying them at proper temperatures—as first intimated as possible by Koch, but until now, not much considered. Even a solution of common washing soda, when heated, becomes active as a disinfectant). San–Jan. 1600 w.

3974. A Draft and Blast Pressuure Gauge. J. H. Kinealy (Read before the Am. Soc. of Heat & Ven. Engs. Describes a new instrument by which pressures can be indicated to within 0.01 inch of water column. Discussion). Heat & Ven–Feb. 750 w.

** We supply copies of these articles. See introductory.*

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Preservation of Gas and Water Pipes from Electrolytic Action.

THIS subject has been given most careful attention, and electrical engineers are apparently making good progress in methods for preventing injury to earth-covered pipes by return currents of the trolley systems. Considerable exaggeration has characterized the popular newspaper accounts of the effects of electrolysis upon gas and water-pipes; but this exaggeration has done no harm, since the injury is an admitted fact, and needs to be guarded against if future trouble is to be avoided.

The present status of progress in the prevention of this evil is set forth by Mr. John Gray in *The Electrical Review* (Jan. 3). The corrosion takes place, not at points where the deflected currents enter the pipes, but where the currents, having passed through the pipes a certain distance, leave these temporary conductors to pass back to the main circuit. The resulting corrosion is proportional to the magnitude of the deflected current, but, as it also depends upon the nature of the surrounding earth-covering, it varies with the quantity of moisture and saline constituents present in the soil. The deflected currents in the single trolley system are shunted from the rails to the pipes through the more or less moist intervening soil, and go back to the main circuit the same way. In some cases the part of the main current thus shunted from the rails amounts to forty or fifty per cent.

Mr. Stuart Smith's investigations in San Francisco led to the discovery of positive and negative zones. "He found that there was a zone in the neighborhood of the power station, where the pipes were positive to the rails; then a short neutral zone; and beyond that a zone—by far the largest—where the pipes were negative to the rails. The resistance of the pipes was found to be made up almost entirely of the resistance of their joints, the section of metal in the pipes having very little influence. This fact explains the unexpected result that the resistance of the gas pipes was found to be rather less than that of the water pipes, the joints of gas pipes having usually less resistance than those of water pipes. This discovery of Mr. Stuart Smith's—that the resistance of underground gas and water pipes is located almost wholly at their joints—has an important bearing on the remedies proposed for getting rid of electrolytic corrosion. In many of the proposed plans the current in the pipes is increased instead of diminished. Evidently at each high-resistance joint a stray current will pass round the joint through the ground, and accelerate corrosion where it leaves the pipe surface. Unless gas and water pipes have been laid down with joints of good conductivity, any effective scheme for reducing electrolytic corrosion in these pipes must reduce the current flowing in them to a minimum."

With reference to a statement made in Mr. Wilkinson's "Notes on Electric Tramways" in the United States and Canada, —which mentions the various phases through which attempts at preventing electrolysis have passed,—Mr. Gray quotes from the work named the following passage:

"As the earth presents an almost infinite mass compared with the rails, it was assumed, in the first instance, that a return of least resistance would be secured by well earthing the negative poles of the dynamos. The coal bill, however, stimulated inquiry into the losses in transmission of electric energy. On many lines of five to ten miles, the voltage at the most distant section between trolley wire and rails was only fifty per cent. of that generated at the station. Some improvement was made by sinking deeper earths into

moist soil and connecting the same to more distant points on the rails. But at the best this was unreliable and variable, and it was noticed that improvement was more marked when attention was turned to the rails themselves as the best return conductors."

Upon this statement the following comment is made: "The conductivity of the rails was improved by bridging over the high-resistance joints by iron and copper bonds. In the next stage, the rails were connected at intervals to the water and gas pipes,—a step which created a satisfactory reduction of resistance in the return circuit, but led to a great increase of electrolytic corrosion and pitting of the gas and water pipes. To mitigate this action, the affected parts of the pipes were connected by cables to the negative poles of the dynamos. This led to the use of a supplementary wire consisting of a bare copper rod, laid between the rails, and connected to the rails on each side of the fish plates. But, as this supplementary conductor made no allowance for the increase of the current as the power station was approached, it was considered better to adopt separate return feeders connected to the rails every five hundred feet, these feeders being increased in section and number as the lines neared the generating station. These feeders were not insulated, and consequently they were only a partial improvement on the supplementary wire."

"Mr. Wilkinson considers that the separate feeder system would completely get rid of the stray currents, if they were insulated. He says: 'Let the negative poles of the dynamos be directly connected to the rails by insulated cables, but not to the earth at the station, and the current will then be kept within the rails and return feeders. The only chance for current to pass to earth would be as a shunt round bond joints of high resistance or insufficient conductivity; and, should this occur, it will only cause electrolytic corrosion at such joints, and not on underground pipes and cables.' This view of Mr. Wilkinson's appears to be erroneous. There will still be a current from the pipes to the earth under the end of each feeder where it is connected to the rail. The corrosion will therefore not be got rid of by this plan, but only more widely distributed over the pipes. That in itself, of course, is an advantage, but something more requires to be done.

"Mr. Jenkins thinks electrolysis can be prevented only by keeping all parts of the rails at the same potential,—a thing impracticable in practice, since Mr. Gray pointed out that it would require an infinite number of rail feeders; but the potential of the rails may be regulated according to a plan proposed by Mr. Jenkins: (1) by adjusting the resistance of the return feeders so that they have all the same drop when equally loaded; (2) by working the return feeders at the same density, and therefore with a drop depending directly on their length. In the first case the return feeders are run in parallel at the station off dynamos in parallel; in the second case, the feeders must be run off separate dynamos at different voltages, or some device must be used to vary the voltage."

This system Mr. Gray thinks more perfect than Mr. Wilkinson's, but it will not completely get rid of electrolytic corrosion. Mr. Harold P. Brown's plan is considered by Mr. Edison (and is also commended by Mr. Gray) as good, but Mr. Gray thinks it would be improved by combining it with the system proposed by Mr. Jenkins.

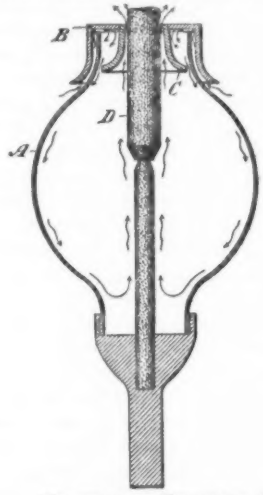
"Mr. Brown's plan is to keep all parts of the underground pipes at least a few volts below the rails and the surrounding earth. If this is carried out, there can, of course, be no current passing anywhere from the pipes to the earth, and consequently no electrolytic corrosion of the pipes. Mr. Brown attains his object by connecting the pipe systems near the power-house by an insulated feeder to one of the dynamos with a voltage twelve volts in excess of the normal voltage of the other dynamos whose negative terminals are connected to the nearest point of the rails. This has the effect of keeping the pipes near the power-station a few volts below the rails above them, and, of course, puts the potential of pipes still further off, below that of the rails by a greater amount.

The drawback to this plan is that it considerably increases the flow of the current in the pipes, and thereby increases corrosion at high-resistance joints. Mr. Brown obviates this somewhat by prolonging his insulated feeder and connecting it to the rails at their most distant point, whereby the great difference of potential between the rails and the pipes at that point, and the consequent flow of current through the pipes, are reduced. Though this system is cheap and considerably reduces corrosion, there must still be a considerable current in the pipes, and, in view of the results of Stuart Smith's experiments already mentioned, this must always produce considerable corrosion in the course of time at the pipe joints. A combination of Mr. Brown's system with the equipotential rail system proposed by Mr. Jenkins would lead to an improvement on both systems, as only the comparatively small stray currents between the feeder ends would be collected in the pipes, and harmlessly drawn off by Mr. Brown's clamp and insulated feeder.

"By such devices there can be no doubt that electrolytic corrosion of pipes, if not completely eliminated, can be very much reduced."

Ventilated Inclosed Arc.

To avoid the use of the higher drop of potential hitherto needed for inclosed arcs as contrasted with open-air arcs, the flattening of the carbon points (which results in greater or less obscuration of the light when the usual potential drop is employed with inclosed arcs), or the mushroom formations upon the carbons which result, in these arcs when a lower potential drop is used, Mr. Louis B. Marks, of New York, has devised a ventilated inclosed arc. The device is described and illustrated in *The Electrical Engineer* (Jan. 15), from which we make an abstract. The envelope, *A*, is provided at the top with a loosely-fitting cap, *B*, touching the cylinder only at four projections, in the center of which is a circular or conical tube, *C*, through which the positive electrode, *D*, is fed to the arc. The negative electrode, by reason of its slower rate of consumption, may be smaller in diameter than the positive. The outer portion of the cap is enlarged into a bell-shaped flange, the rim of which is brought closely adjacent to the exterior wall of the envelope. Thus there is provided a narrow annular passage for the outside air into the envelope, one of the walls of this passage being formed by the envelope, which, by reason of its higher temperature, heats the entering air in its transit. The tubular opening through which the electrode feeds is made slightly conical in shape, the enlargement at the top being only a little greater than the diameter of the electrode, so as to permit a free feed of



VENTILATED ENCLOSED ARC

the latter and to afford an obstructed egress for gases from the envelope.

The lower part of the tube is flanged away from the electrode as shown, this form serving as a deflector for the upward currents around the positive carbon, the flange at the same time forming a deflecting-wall for the ingoing air and directing the latter outwardly toward the walls of the envelope. The tendency with this arrangement is for all egress to take place by way of the central tubular opening, and all ingress by way of the bell-shaped chamber.

The arrangement of the cap, as above described, deflects the ingoing air into the downwardly-moving portion of the con-

vection current, where it is intimately mixed with the gases already formed in the envelope and raised in temperature, so that it is intensely hot by the time it reaches the arc.

A highly-important result which follows from the distribution of air-currents as described is that the resistance of the arc-stream, instead of being considerably increased, as is the case with other inclosed arcs, remains practically the same as in an open-air arc. The length of arc for a given drop of potential is therefore practically the same as that of an open-air arc of the same drop of potential.

Because of the flow of convection currents of arc gases mixed with atmospheric air, the electrodes do not burn blunt, as in ordinary inclosed arcs, but have much the same shape as points formed in open air. The crater formed in the positive is substantially uniform in curvature, while the apex of the negative is pointed and well centered with reference to the crater of the positive. Thus there is practically no obscuration of light, as in the usual inclosed arcs where the electrodes burn to blunt points. The light is claimed to be steady and efficient at practically as low drop of potential as with open-air arcs.

In addition, it is asserted that lamps with this type of envelope can be run at forty-five or fifty volts, and the carbons have a life of fifty hours. The difficulties named above arise from the isolation of the carbons from oxygen, and the ventilation appears to be just the remedy needed.

German Report on Glow Lamps.

A TRANSLATION of a report of a committee of representatives of German electric-supply undertakings, from *Electrotechnische Zeitschrift*, is printed in *The Electrician* (London, Jan. 3). This report deals with glow-lamps and their faults, with a view to their improvement, and describes an elaborate experimental investigation, with the results and conclusions arrived at by the committee. We will present the main features of this important report in the form of an abstract.

The first question to be settled was the determination of existing faults, and how far general complaints of quality and life were justified by the facts.

In general, these experiments have shown that the complaint of consumers—*viz.*, that the lamps were bad—is quite justified. The reasons for this opinion are found in careless sorting, careless marking, low efficiency, and short life. Every electrician who is accustomed to make photometrical tests will have found that the sorting and marking of lamps of nearly all makers leaves much to be desired. In fact, nearly always the candle power and watt consumption differ from the figures guaranteed.

Tests made on about seventy 16-c. p. lamps for 110 volts, and supplied by eight different German firms, showed a variation in the candle-power from 7.82 to 22.85 (*Normal-Kerze*). While the lamps were marked for a watt consumption of 3¼ to 3½ watts per candle, the current absorbed varied from 0.43 to 0.63 ampere, and the watt consumption per candle from 2.8 to 6.3 watts.

Tests made on another twenty 16-c. p. lamps for volts, supplied by a well-known firm, showed a variation in the candle-power of from 10.21 to 21.6 candles, or more than 50 per cent. These lamps were specially supplied for testing purposes, and consumed 4.1 watts per c. p.

Of five 16-c. p. 3½-watt lamps, made by another well-known firm and picked out of a larger quantity, one gave out at once, another emitted only 10.21 c. p., a third 13.6, c. p. and the remainder 16.02 and 16.63 c. p. The average watt consumption was 3.7 watts per candle.

In the case of another ten 16-c. p. 110-volt lamps, made by a third well-known firm and also taken from a larger quantity, the candle-power ranged from 15.9 to 22 candles, and the average consumption was 3½ watts, but, after forty-eight hours, the candle-power had fallen by 40 to 60 per cent., while the average watt consumption had risen to 5.6 watts per candle.

In 2½-watt lamps examined the conditions were found to be the same. Only a few lamps gave one candle for every 2½ watts, and most makers supplied 3½-watt

lamps as 2½-watt lamps without any scruple.

Of course these results are calculated to destroy confidence in the statements of the manufacturers of glow-lamps, and they have only themselves to blame for the discredit. A reason is assigned for the fact that the difference in illuminating power between an 8-c. p. lamp and a 20-c. p. lamp which has been purchased as a 16-c. p. lamp is not at once detected. Everyone who has carried out photometrical work will know that, even for a trained eye, such detection is difficult. The reason for this is mainly that the specific luminous power—*i. e.*, the luminous power per unit of surface—is generally the same in lamps of different candle power. If a 16-c. p. lamp is placed in a group of 20-c. p. lamps of the same specific luminous power, then for most eyes it is difficult to observe the difference, and for the general public probably it is impossible. If the sorting and marking of lamps are badly done, examinations of lamps as to economy and life show no better results.

The useful life of lamps is here meant,—that is, the time in which the candle power of the lamp becomes lessened about twenty per cent. A lamp deteriorated to that extent should be replaced, although it may continue to give light for a much longer period. Generally a period of 800 to 1,000 hours is given for 3- to 3½-watt lamps. Formerly a period of 1,000 hours was usual. As a rule, however, less than 800 hours is not given. Such life can easily be attained in high-vacuum lamps, when life is understood to be the time from the first use of the lamp to its final giving out. On several occasions lives of 1,500 to 2,000 hours have been obtained. Such figures are, however, of absolutely no value, as all lamps, before giving out, have already reached a small candle-power, and are insufficient.

By a "candle power" the "mean candle power" should be understood, measured in two directions vertical to each other. The candle power varies, as is well known, according to the position of the lamps, and can vary as much as twenty per cent. between two positions. It is difficult to say in which position a lamp possesses its largest candle power, even when we are comparing lamps of the same kind. It will be nearly correct, if the lamp is placed in such a position on the photometer that an imaginary straight line passing through the terminals of the filament is at right angles to the photometer bench. By "mean candle power" will then be understood the average attained by this measurement, and a second one in which the imaginary line is rotated through 90°.

If this "useful life" and "mean candle power" be employed for calculations, then bad results are obtained with all lamps at present in the market. As an instance, it may be mentioned that in ten 16-c. p. 3½-watt-lamps of well-known makers the average actual life was 1,450 hours, and six lamps even attained a life of over 2,000 hours. The "useful life," however, was only about 400 hours. Five lamps of the same size, of another maker, had an actual life of 741 hours, and a "useful life" of 366 hours. Ten lamps of the same size, made by a third firm, gave an average actual life of 1,435 hours; six lamps burned for more than 2,000 hours; the "useful life," however, was only 150 hours.

It must be remembered that the lamps examined were those produced by manufacturers of the better class; the lamps produced by smaller concerns are not likely to be even as good.

In ordinary lamps, such as consumers buy in shops, the "useful life" should never be taken to exceed 400 hours, and, therefore, in calculation, this figure should be employed, instead of 800 to 1,000 hours.

The remarkable fact is clearly brought out in this report that, during the fifteen years since glow-lamps have been in use, they have deteriorated, instead of improved.

The report concludes with a draft of a specification for the supply of lamps of this kind, which is recommended for adoption when contracting, and it includes a standard of voltage, candle power, and watt-consumption with which they must accord, when tested, within plus or minus 2 per cent. in the voltage, and plus or minus 6 per cent. in the two other require-

ments. It also includes a description of the tests, and a guarantee, to be given by the seller, that, at the end of the term agreed upon as the useful life of the lamps, they shall not have deteriorated more than twenty per cent. in illuminating power.

Present Status of the Storage Battery.

M. MAURICE BARNETT, in a paper recently read before the Northwestern Electrical Association (*Electrical Engineer*, Jan. 22), attributes the change of attitude of electrical engineers and station managers toward the storage battery to four causes.

"First: litigation no longer stands in the way of the use of any of the standard types of batteries. Second: the application of special types of batteries to special kinds of work has resulted in a vastly improved performance of battery plants in meeting the exigencies of station work. This refers specially to performance of battery in acting as a reservoir for storing the energy represented by the difference between the average and the maximum load, as a regulator of pressure on circuits subject to varying demands, and as a transformer using high voltage charging currents and discharging at any lower voltage desired. Third: it is generally recognized that plants part steam power and part storage battery are cheaper than all steam power and part storage battery plant would be for the same work. Fourth: the use of batteries in sub-stations frequently permits a saving in conductors between the central and the sub-station.

"With regard to litigation, it may be said that formerly, when one bought a storage battery, one contracted the liability to a law-suit at the same time. It is now generally known that the incubus on the storage-battery business has been removed. One large company, ably managed, has obtained control of this business by securing to itself the right to manufacture in the United States storage batteries of all the important types heretofore developed."

The National Electrical Exhibition.

OF this exhibition, to be held in New York in May, of the present year, *The Electrical World* (Feb. 15) says that "the numerous contracts already closed by the National Electrical Exhibition Company assures the success of this enterprise, which contains so much of interest to all those engaged in the electrical industries. All of the larger companies have taken space and the majority of them have planned features that will be both instructive and interesting to the general public, showing not only the practical applications of electricity, but how results are accomplished, etc.

"All the branches are already represented, exhibits of electric lighting, electric railways, telephones and telegraphs being in preparation, as well as displays of electrical supplies. This being the first exhibition of the kind ever given in New York, there appears to be a general desire on the part of all concerned to make its proportions truly representative of the electrical industries.

"One of the most attractive and instructive exhibits will be that of the Edison Electric Illuminating Company of New York. This display will occupy a space of over 1000 square feet, and will comprise a complete demonstration of the applications of electricity for domestic purposes. The most improved methods of house lighting will be shown in detail, and electric heating; also cooking by electricity."

The indications are at present, that this is to be one of the most important electrical events of the year, when taken in connection with the great gathering of electricians which will take place, also in New York, while the exhibition is going on.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

*3565. Electric Lighting in 1895 (The history of the electric light industry in the United Kingdom). Jour Gas Lgt–Dec. 31. 900 w.

*3579. The Electric Lighting of Walsall. Ill. (Descriptive). Elec Rev, Lond–Jan. 3. 2000 w.

3618. The Edison Electric Illuminating Co.

We supply copies of these articles. See introductory.

of New York. Ill. Jos. Wetzler (A full historical account of the growth and progress of this company). Elec Eng-Jan. 8. 16000 w.

*3632. The Glow Lamp Question in Germany (Report of a committee of Representatives of German Electric Supply Undertakings. From the *Electrotechnische Zeitschrift*). Elect'n-Jan. 3. 3000 w.

*3634. Ayr Electricity Works (Illustrated description). Elec Eng, Lond-Jan. 3. 5500 w.

3644. Insulation and Testing of Arc Circuits. Alex. Dow (A discussion regarding the insulation resistance necessary, and practical tests required, with circuits of 100 arc lamps in series, the conductor being "weatherproof" wire, strung on glass insulators in the usual manner). Elec Engng-Jan 2000 w.

3664. The Absorption of Light Rays Through Transparent and Translucent Glass. Th. Stort (Considering whether losses of light take place and the extent, etc.). Pro Age-Jan. 15. 800 w.

3670. The Marks Ventilated Enclosed Arc. Ill. (An envelope designed by Louis B. Marks, in which a limited circulation of air takes place). Elec Eng-Jan. 15. 700 w.

*3683. High Tension and Low Tension Supply Albert Gay (The object of the article is, if possible, to reduce the friction existing between the votaries of these two systems. The faults of each are enumerated, and their effect upon each other pointed out). Elec Rev, Lond-Jan. 10. 2800 w.

3770. American Apparatus in the Municipal Lighting Plant, Odessa, Southern Russia (Descriptive of the plant and the special and peculiar requirements that had to be met). Elec Eng-Jan. 22. 1400 w.

3771. Modern Apparatus vs. Existing Conditions. W. J. Buckley (Abstract of a paper read before the Northwestern Elec. Assn., Milwaukee. Points of interest in electric lighting, with suggestions to buyers of new apparatus). Elec Eng-Jan 22. 3500 w.

3772. Storage Batteries in Central Stations. Maurice Barnett (Abstract of a paper read before the Northwestern Elec. Ass'n. Reviewing the causes of change in public sentiment in regard to the storage battery, and considering, in a general way, the adaptability, performance and economy of the storage battery in a central station). Elec Eng-Jan. 22. 2800 w.

3863. The Cost of Incandescent Lighting from Central Stations. W. D. Marks (An argument and incentive for higher economy lamps). Elec Eng-Jan 29. 1000 w.

*3890. The Depreciation of Electric Arc Lighting (Critical review of a paper by Albert Scheible, entitled "Illumination *versus* Glare"). Jour Gas Lgt-Jan. 21. 1300 w.

3901. Illumination of the Municipal Casino of Royan (Illustrated description). W Elec-Feb. 1. 1000 w.

*3964. German Wiring Rules (Abstract from the *Elektrotechnische Zeitschrift*. Abstract of the more important rules, which apply to electrical installations with potentials up to 250 volts between any two conductors or one conductor and earth, with the exception of underground networks and electro-chemical plants). Elect'n-Jan. 24 1200 w.

Power.

*3578. The Electrolytic Action of Return Currents in Electrical Tramways. John Gray (Reference is made to the experiments of Mr. Stuart Smith, and the writings of Mr. Wilkinson, with Mr. Jenkins' discussion on Mr. Wilkinson's paper. Mr. Brown's system is explained and comments are made). Elec Rev, Lond-Jan. 3. 2000 w.

*3636. Electricity in Mining. Sydney F. Walker (A review of the progress of the past twenty years). Elec Eng, Lond-Jan. 3. 2000 w.

3646. The Detroit Railway; Its Power House and Other Features (Illustrated detailed description). Elec Ind-Jan. 2000 w.

*3649 A Novel Electric Brake. Frank M. Ashley (Illustrated description of a new system with a small storage battery in each car). Elec Foa-Jan. 700 w.

*3652. The Compound Dynamo. George F. Sever (Lecture delivered before the Henry Electrical Club. The paper treats of the function, uses, methods of working, etc.). Elec Pow-Jan. 3000 w.

*3653 Alternators. M. I. Pupin (Historical review of the steps that led to the use of the alternator and the transformer. The method of armature winding is illustrated, and ways of constructing the alternator). Elec Pow-Jan. 2000 w.

3673 Selecting an Electric Motor. G. H. Zahn (Difficulty in the selection due to the imperfect manner of rating electrical machinery). W Elec-Jan. 18. 2300 w.

3675. Official Report of Experiments in Electric Propulsion on the Erie Canal (Full text of the report of Charles R. Barnes, from which it will be seen that the system is looked upon with much favor). W Elec-Jan. 18. 2200 w.

3680. Three-Phase System at Concord, N. H (Illustrated description). Elec Wld-Jan. 18. 1600 w.

*3685. "Past and Present Obstacles in the Storage Battery Development." L. Epstein (A review of the paper on this subject lately presented by Mr. Carl Hering, and claiming that England is far in advance of the United States in the development of the storage battery). Elec Rev, Lond-Jan. 10. 1600 w.

3713. Distribution of Electrical Energy from a Central Station (Abstract of, and comment on, a paper read by William C. L. Eglin at the meeting of the Engineers' Club at Philadelphia. He described in detail the method of distributing electrical energy in large cities). Am Gas Lgt Jour-Jan. 20. 1200 w.

*3714. Motor Care and Repair at Indianapolis. (Scientific testing methods in daily practice—Improvements in armature coils). St Ry Rev-Jan. 15. 3000 w.

*3718. The Booster in Railway Work. J. B. Scott (Largely descriptive of its use in the City and Suburban Railway, of Baltimore, Md). St Ry Rev-Jan. 15. 1600 w.

*3720. The Storage Battery for Street Car Traction (A protest from storage battery people against an article in the September number of this paper). St Ry Rev–Jan. 15. 2200 w.

3727. The Storey Motor or Dynamo (Illustrated description of a machine not only transmitting power in the ordinary way, but specially adapted for direct driving and an enormous range of work). Can Eng–Jan. 1200 w.

*3732. An Electric Pumping Installation. Philip R. Bjorling (Illustrated description of an electric pumping installation which has been working without intermission since 1891). Col. Guard–Jan. 10. 1200 w.

*3760. A Steel Cased Motor (Illustrated description of machines claimed to be practically devoid of external magnetic field, and on this account well adapted to ship work. Test runs are given). Elect'n Jan. 10. 400 w.

3769. The Doushea Method of Charging the Fields of Large Central Station Dynamos (The advantages and disadvantages of the three methods are stated, and the Doushea Method, which is claimed to obviate the difficulties of the three systems, is explained). Elec Eng–Jan. 22. 1000 w.

3782. Arnold Electric Power Station System (Illustrated description of the central station of the Fort Dodge, Ia., Light and Power Company. It is the first plant built according to this system). Elec Wld–Jan. 25. 2000 w.

*3850. Trials of Alternate-Current Plant at Dover Electric Supply Station (Extracts from a report by Profs. A. B. W. Kennedy and S. P. Thompson. The tests had for their main object the determination of the capacity and efficiency of the plant). Elect'n–Jan. 17. 2000 w.

*3853. The Better Utilization of Central Stations. Dr. Rasch in *L'Industrie Electrique* (Favoring the reduction of the tariff for energy consumed by motors). Elec Rev, Lond–Jan. 17. 2000 w.

3864. Electric Elevators, with Detailed Description of Special Types. Frank J. Sprague (Read before the Am. Inst. of Elec. Engs. 5000 in operation in New York city alone. Details of recent machines). Elec Eng–Jan. 29. 8000 w.

*3953. Alternate Current Transformers (Review of a lecture by Dr. J. A. Fleming, the first of four Cantor lectures on this subject). Engng–Jan. 24. 1000 w.

4004. The Calculation of Alternating Current Transmission Circuits. P. M. Heldt (The article explains in a clear and simple manner the method of calculating the factors to apply in the determination of the size of conductors for alternating circuits). Elec Wld–Feb. 8. 2500 w.

4047. Electric Power Transmission of Niagara. Ill. Orrin E. Dunlap (An account of the rapid progress in the power development). W Elec–Feb. 8. 1800 w.

4049. Central Station Economies. Leland L. Summers (Address delivered before the Northwestern Elec. Assn., Milwaukee. Consideration of the factors which are apt to prove a source of loss). W Elec–Feb. 8. 5000 w.

4050. Are Lower Street Car Fares Practicable? (The past, the present, and the future of electric street railroads is considered at length, arriving at the conclusion that the difficulties are at present insurmountable). Elec–Feb. 5. 2600 w.

4053. Recent Improvements in Storage Batteries. Herbert Lloyd (A paper read before the N. Y. Elec. Soc. The writer having just returned from a tour of inspection of the storage battery plants of Europe). Elec–Feb. 5. 2500 w.

Telephony and Telegraphy.

*3635. The Block Telegraph System. J. Pigg (An examination of some of the weak points of the system). Elec Eng, Lond–Jan. 3. 2000 w.

3639. Centralization of Transmitter Batteries in Telephone Exchanges. Ill. Kempster B. Miller (The advantages derived from such a centralization are set forth and the methods explained). Elec Wld–Jan. 11. 2500 w.

*3650. Automatic Telephone Exchange Systems. Edward P. Thompson, and Ward Decker (The object of this article is to show, in as brief a manner as possible, the operation of each system; but the relative merits of each have not been alluded to further than necessary for a correct description of the same). Elec Pow–Jan. 4400 w.

3672. Field's Compensating Telephone. Ill. (Patent of Stephen D. Field. A mechanical device in the telephone which acts to accentuate or magnify the more rapid and feebler vibrations while diminishing the amplitude of the heavier vibrations). Elec Eng–Jan. 15. 1400 w.

*3759. Electric Tramways and Telephonic Disturbances. C. S. Du Riche Preller (Investigations of the effects of the working of electric tramways in telephones, with a view to determining (1) which of the overhead contact systems is most liable to cause telephonic disturbances, and (2) whether the disturbances, if any, are due to induction, leakage, or to other causes). Elect'n–Jan. 10. 2700 w.

*3761. Cable Communications with South Africa (The connections are given, and an explanation of the recent delays). Elect'n–Jan. 10. 1000 w.

3789. A New Automatic Telephone Exchange System). Illustrated description of the system devised by Mr. Romaine Callender, which is intended to do away with the employment of operators). Eng News–Jan. 23. 1300 w.

3865. The "K R" Law as Applied to Quadruplex Circuits. W. Finn (Data affording an approximate idea of the efficiency limitations imposed by the K R law as applied to quadruplex working in at least one particular case). Elec Eng–Jan. 29. 1500 w.

4009. Portable Telephones. From *N. Y. World* (The system to be installed on the Brooklyn Bridge cars. The invention of Kingsley L. Martin). Lord's Mag–Feb. 2300 w.

Miscellany.

3570. What Electricity Is.—Its Every-Day Applications Clearly Explained (Reproduced from a chapter on "Electricity and Its Future," in a book by Charles H. Cochrane). Bos Jour of Com-Jan. 11. 1800 w.

3576. A Year's Electrical Progress. Charles G. Armstrong (From the *Chicago Record*. Reviews the progress in all the branches of electricity for 1895). W. Elec-Jan. 11. 3400 w.

3577. Consumption of Electricity in Paris, Ill. (Data obtained from the proceedings of the International Society of Electricians, showing rapid growth during the last few years). W. Elec-Jan. 11. 1200 w.

*3580. The True Resistance of the Arc. Silvanus P. Thompson (In reply to claims made by Prof. Ayrton and in criticism of conclusions reached by him). Elec Rev, Lond-Jan. 3. 2400 w.

*3613. Atmospheric Electricity. Arthur Schuster (Delivered before the Royal Inst. of Gt. Britain. A review of early experiments and observations, with explanation of various phenomena). Nature-Jan. 2. 8000 w.

*3633. The Relation between the Atom and the Charge of Electricity Carried by It. J. J. Thompson (Abstract from the *Phil. Mag.* The subject is considered by the writer to be of fundamental importance, and closely related to chemical and electrical phenomena. The first number gives a hydro-dynamical illustration). Elect'n-Jan. 3. Serial. 4800 w.

3638. A Method for the Detection of Weak Dynamo Fields. Buckner Speed (Description of a method used by the writer many times, which has never failed to correctly indicate the weak spool). Elec Wld-Jan. 11. 600 w.

*3648. Electric Arc Welding. William H. Handy (A general review of the practical progress of welding and metal working by electricity, with particular attention to welding by means of the electric arc. Abstracts of the most important articles in the electrical journals are given, together with references to other articles). Elec Pow-Jan. 5000 w.

*3651. A Systematic Treatise on Electrical Measurements. Ill. Herschel C. Parker (The subject is to be treated in a systematic manner and the classification thoroughly worked out). Elec Pow-Jan. Serial. 1st part. 3000 w.

3681. The Electric Manufacture of Aluminum (Illustrated description of process with interesting matter bearing upon the subject). Elec Wld-Jan. 18. 2000 w.

3682. Resonance in Circuits Possessing Self and Mutual Inductance, Resistance and Capacity. A. S. Dunstan (A short sketch of the phenomenon of resonance in simple circuits containing self-inductance, resistance and capacity is given, and the general method of finding the conditions necessary for resonance to occur is shown. The paper is concerned solely with the phenomena of resonance in the primary circuit). Elec Wld-Jan. 18. 1200 w.

3706. A New Electrical Current Rectifier (Consular report from Frankfort, Germany. An invention of Mr. C. Pollak which solves the hitherto stubborn difficulty of converting an alternating into a direct electrical current with a loss of but a trifling percentage of its energy). Eng & Min Jour-Jan 18. 1000 w.

†3722. The Chemical Potential of the Metals. Wilder D. Bancroft (Having in a previous paper communicated the electro-motive force of certain cells, the author, in the present paper, considers the relation between single-liquid polarizable cells and the corresponding constant reversible cells of the Daniell type). Phys Rev-Jan.-Feb. 5400 w.

*3757. Volt and Ampere Meters. J. Warren (The first paper deals with voltmeters. Describes various instruments). Elec. Lond-Jan. 10. Serial. 1st part. 1500 w.

*3762. Device for Protecting Physical Institutes Against Disturbance by Electric Railways. O Frölich (Abstract of a paper read before the Elektrotechnischer Verein of Berlin). Elect'n-Jan. 10. 2500 w.

3781. Magnetic Properties of Iron and Steel. J. A. Kingdon (From the London *Electrical Review*. The effect of temperature). Elec Wld-Jan. 25. 1200 w.

†3803. The Magnetic Properties of Nickel Steel. Edward P. Buffett (Tests described were undertaken in the hope of attaining a definite conclusion. The general theory involved; apparatus; data and calculations, experiments, etc.) Stevens In-Jan. 3200 w.

*3849. Commutatorless Dynamos. Ill. James Whitcher (Criticism of statements in an article by Ricardo Malagoli on "An Alternating Rotary Magnetic Field and its Application"). Elec Eng, Lond-Jan. 17. 1800 w.

*3952. Military Electric Engineers (A proposition that the members of the Institution of Electrical Engineers shall place at the disposal of the government their technical knowledge for the purposes of national defence, and possibly also for offence). Engng-Jan. 24. 2200 w.

*3965. Dr. Hopkinson's Presidential Address to the Institution of Electrical Engineers. Elect'n-Jan. 24. Serial. 1st part. 5000 w.

3981. On the Motions of the Luminous Glow in Rarefied Gases Produced by Electric Oscillations. J. Elster and H. Geitel, in *Wied Annalen* (An account of experiments which give further proof of the nature of cathode rays). Elec Eng-Feb. 5. 1400 w.

3984. The Gross Untrustworthiness of Fuse Metals and Appliances as a Means of Protection for Electric Circuits. The Remedy. Ill. William McDevitt (A paper giving an account of tests made in Philadelphia, and including parts of discussions following papers on this subject, with conclusion suggesting remedy). Elec Eng-Feb. 5. 6000 w.

4005. Unit Systems and Dimensions. T. Proctor Hall (A paper read before the Iowa Acad. of Science. Showing that the C. G.S. system is an arbitrary one, and may therefore naturally give rise to disparities between classes). Elec Wld-Feb. 8. 450 w.

INDUSTRIAL SOCIOLOGY

The Education of the Negro.

IN *American Magazine of Civics* for February, Mr. J. L. M. Curry discusses the meager progress made in the education of the negro element of the southern population, and takes a decidedly pessimistic view of the situation. He evidently regards the negro as an unassimilable element in American civilization, and quotes liberally from other observers to substantiate this position. He presents a rather startling array of facts, and is particularly emphatic in condemning the indiscriminate giving to solicitors for southern educational institutions, placing it in the same category as indiscriminate giving to medicants, which charitable associations are earnestly endeavoring to suppress. The assumed relation of the negro race to other races is strongly lined in the following quotation:

"After the facts, hard, stubborn, unimpeachable, regrettable, which have been given, we may well inquire whether much hasty action has not prevailed in assigning to the negro an educational position which ancient and modern history does not warrant. The partition of the continent of Africa by and among European nations can hardly be ascribed solely to a lust for territorial aggrandizement. The energetic races of the north begin to realize that the tropical countries—the food- and material-producing regions of the earth—cannot, for all time to come, be left to the unprogressive, uncivilized, colored race, deficient in the qualities necessary to the development of the rich resources of the lands they possess. The strong powers seem unwilling to tolerate the wasting of the resources of the most fertile regions through the apparent impossibility, by the race in possession, of acquiring the qualities of efficiency which exist elsewhere. The experiment of the Congo Free State, one of the richest and most valuable tracts in Africa, established and fostered under propitious circumstances by the king of Belgium, seem likely to be a barren failure, and to prove that African colonization is not a practicable scheme without State subvention, or the strong, overmastering hand of some superior race. It requires no superior insight to discover that human evolution has come from the energy, thrift, discipline, social and political efficiency of peoples whose power is not the result of varying circumstances, of the cosmic order of things which we have no power to control.

"The negro occupies an incongruous position in our country. Under military necessity slaves were emancipated, and all true Americans accept the jubilant eulogium of the poet, when he declares our country

> A later Eden planted in the wilds,
> With not an inch of earth within its bounds
> But, if a slave's foot press, it sets him free.

Partisanship and an altruistic sentiment led to favoritism, to civic equality, and to bringing the negroes, for the first time in their history, and without any previous preparation, 'into the rivalry of life on an equal footing of opportunity.' The whole country has suffered in its material development from the hazardous experiment. The south, as a constituent portion of the union, is a diseased limb on the body, is largely uncultivated, neglected, unproductive. Farming, with the low prices of products, yields little remunerative return on labor or on money invested, and, except in narrow localities and where 'trucking' obtains, is not improving agriculturally, or, if so, too slowly and locally to awaken any hopes of early or great recovery. Crippled, disheartened by the presence of a people not much inferior in numbers, of equal civil rights, and slowly capable of equal mental development, or of taking on the habits of advanced civilization, the whole white people of the south are deprived of any considerable increase of numbers from immigration, and any

large demand for small freeholds, and are largely dependent on ignorant, undisciplined, uninventive, inefficient, unambitious labor. Intercourse between the Slavs and the tribes of the Ural-Altaic stock, fusion of ethnic elements, has not resulted in deterioration, but has produced an apparently homogeneous people, possessing a common consciousness. That the two diverse races now in the south can ever perfectly harmonize, while occupying the same territory, no one competent to form an opinion believes."

Business Men and Social Theories.

MR. C. R HENDERSON, in *The American Journal of Sociology*, treats of differences between the views of the labor question taken by students of sociology and those held by the "captains of industry," by which term he means employers of labor; and he thinks it would be strange if these differences did not exist, and the "captains of industry" did not "sometimes manifest a militant spirit," when the differences in the training, lifework, and general characters of the two classes named are duly considered. "Competitive commercial life is not a flowery bed of ease, but a battle-field where 'the struggle for existence' is defining the industrially 'fittest' to survive.

"In this country the great prizes are not found in congress, in literature, in law, in medicine, but in industry." The successful man is praised and honored for his success. The social reward of business prosperity, in power, praise, and luxury, is so great as to entice men of the highest intellectual faculties. Men of splendid abilities find in the career of a manufacturer or merchant an opportunity for the most intense energy. The very perils of the situation have a fascination for adventurous and inventive spirits. In this fierce, though voiceless, contest a peculiar type of manhood is developed, characterized by vitality, energy, concentration, skill in combining numerous forces for an end, and great foresight into the consequences of social events. If the character is further analyzed, we discover, along with some apparent heedlessness of pain and many compromises with conscience, an integrity about contracts which makes it possible to build the business of the world on credit. Those who live in retirement and simplicity are apt to find the swift, brusque, imperious, and impatient manners of the successful business man somewhat severe and offensively dictatorial. But the ceremonial tediousness of the parlor would be out of place in the office of one who must think rapidly enough to keep thousands of telegraph operators, stenographers, clerks, and other employees in operation. Dainty speech and elaborate politeness under the conditions of life in a great commercial house would have all the effects of crime.

"By extending this study to the psychical processes of typical business men we might be enabled to regard some social phenomena in a new and stronger light. Great business men, like some distinguished generals, let their deeds speak for them. They say, with some touch of contemptuous sarcasm and cynicism, they can hire talkers and buy books. So that to interpret their inner life we must seize the rare occasions when they venture upon speech. As the number of college men among merchants increases, the points of contact with academic men are likely to increase."

As illustrating these differences, a number of passages from speeches of representative business men are quoted. One of these, from an address of Mr. William Whitman, of Boston, is cited as voicing "a certain feeling of his peers." This speech was delivered before assembled representatives of the great commercial clubs at St. Louis.

"Mr. C. D. Wright had suggested that in the future employers would be held responsible before the law at the bar of public opinion for strikes; and that it would be held to be the duty of employers during prosperous times to set aside a fund for the payment of wages in times of adversity. Mr. Whitman declared both propositions to be monstrous, and asked of the gentlemen present: 'What do you think of them? Do you think that this new philanthropo-ethico-economic manage-

ment will attract the investment of capital? Who are the men engaged in promulgating these so-called reforms, ostensibly for the benefit of workingmen? Are they not, for the most part, theorists with unbalanced minds, who have adopted unsound principles and are pushing them to the extreme? Are they not men without knowledge and experience necessary to deal successfully with men or affairs? Why should men of affairs permit them, undisputed, unanswered, unchallenged, to arrogate to themselves the right to teach the world how we shall conduct our business?'

"This speaker gives his reasons for thinking that business men carry in their own bosoms and interests the guarantees of social welfare. 'The purposes of business, the sense of responsibility to others, the danger of personal loss and possible failure, and the hope of reward are the surest guarantees for the conduct of affairs in the mutual interests of employer and employed.'"

Notwithstanding that the force of these views, regarded as typical expressions of those held by the "captains of industry," is fully admitted, Mr. Henderson is not prepared to admit that "the student of society is without a function, a mere useless parasite, or, at best, a phonographic reporter of the dead past." He thinks "it is the duty of the scholar to place and keep before the public the supreme criterion of social conduct, the common welfare," which is apt to be but dimly recognized in the uproar of business, even if it be not altogether obscured.

"These quotations prove that many essential elements are ignored by very able and upright men. They imply that there is at least one class of the community who have no interest in the issue of social strifes, and no right to be heard on their own behalf. They imply that economic forces are automatic, natural, and not human and ethical. The influences which fix the rate of wages are treated as if they belonged to the same category as the law of gravitation. Human intelligence, will, and aspiration are excluded from consideration by such logic. Economics is put on the same level as biology, or even chemistry. The corrective of this attitude of some practical men is not abuse, but facts, —just such facts as the studies of social history supply in abundance. It is the duty and function of the theorist to confront this automatic and fatalistic class theory of business with the history of factory legislation. . . . The social position of the 'social theorist' is an advantage. The nature of his studies compels him to come into touch with persons of all classes and interests. He hears and reads on all sides. His associations are with the refined, and his ideals of life are formed in the best company. But his professional pursuits compel him to weigh the claims of the entire community."

Rural Loan Associations in Germany.

THE following is an abstract of a consular report for December, which gives interesting details.

Herr Raiffeisen, mayor of Flammersfeld, about the end of the year 1848, had the care of thirteen parishes, with a population of about five thousand. Many well to-do land owners in this population were in the clutches of local money-lenders, who ruled the community. With much difficulty Raiffeisen succeeded in getting all the members of the parish of Flammersfeld to join together and form, in common, an unlimited-liability society, and thus the first rural company for lending money out on interest (*Dahrlehnskassen Verein*) was founded. The system worked so well that, at the end of ten years, all the small peasants who had hitherto been a booty for the money-lenders became free men. Then it was that a commission was sent from Berlin to study the system of forming coöperative associations for lending money.

The strength of the Raiffeisen associations consists in unlimited liability. No member can escape, for the association is not responsible for any of its members, but merely for the sums of money deposited. Their safety is so trusted that bankers have declared themselves ready to grant the associations credit, merely on the ground of their unlimited responsibility and without asking for any other guaranty.

In an association of some fifty-eight members, the community being in prosperous circumstances, each member can safely be calculated to be worth 10,000 marks ($2,400). Thus the society can be said to dispose of a capital of 580,000 marks ($140,000). As the directors of the associations are not allowed to speculate in any way, and are empowered to lend money only to members, a complete security is offered.

Servants residing in places where there are no Raiffeisen Vereine frequently place their savings in the nearest associations, and *Pfennigsparkassen* have been instituted, where savings of ten pfennigs are accepted on deposit from children.

Any one desiring a loan is obliged to proceed as follows: (1) he must at an early date apply either to the director or to the accountant of the association; (2) he must explain for what purpose he requires the money; (3) how much *he can pay back yearly;* (4) somebody with whom he is on friendly terms must "go security" for him. The third point is a standing rule of the associations. However, respites are granted, and the return of payments may be made during the year in the smallest sums. In any case where the accountant or directors divulge anything with reference to a credit which has been promised and vouched for, a fine of 30 marks ($7.50) is imposed on them.

As those who have become sureties for their friends are responsible, it is for their interest to see that the loan obtained is used for the purpose given out, and, if not, to notify the association, and thus shield themselves. Where both the borrower and he who answers for him meet with heavy losses through no fault of their own, the association is empowered to cover the deficit resulting from the reserve fund. This, however, is most rare.

The various Raiffeisen societies are in the habit of laying in a stock of different articles, such as artificial manures, fodder, fuel, and flour.

After the second or third year the associations generally begin to accumulate cash surpluses. The loans draw 3½ per cent. interest. When the borrower obtains his loan, he pays ½ per cent., which goes into a fund called "provision." The gains are divided each year into three funds: (*a*) indivisible fund, (*b*) a reserve fund, (*c*) a fund out of which dividends are made to members. Losses are paid out of the reserve fund. The indivisible fund is varied according to yearly requirements. Thus the associations make a gain of ½ per cent. Another species of association is the *Schulze-Delitzsch*, or credit, association, which affords means for purchasing materials or borrowing money. Associations of this type are speculative. They operate without limitations, and the gains are divided in a ratio corresponding to the magnitude of members' shares. The basis of their operations is not so safe as that of the Raiffeisen Vereine, and a number of them have been wound up in consequence of over-speculation. In 1893 there were 1038 societies on the Schulze-Delitzsch system, with a credit estimated at 1,579,000,000 marks ($393,000,000). There were also 713 of the Raiffeisen Vereine, with a credit business of 25,000,000 marks ($6,000,000).

There is also the Bavarian *Landesverbande*, and the Genossenschafts-Kassen, which last require no profits and pay no dividends. The only salaried member is the cashier, the different members of the board acting in a purely honorary capacity. As a result, they are in a position to offer a fair interest to their creditors, and exact a modest rate of interest from debtors.

Municipal Ownership.

THE extension of this system to electric light plants is handled without gloves by Mr. John A. Britton in a letter recently sent to the board of trustees of the city of Alameda, Cal. Incidentally the extension of the system to other industries, as has recently been the tendency in many cities, is severely reprobated. We shall, in this review of Mr. Britton's letter (published in *American Gas Light Journal*, Jan. 20), attempt to present some of the stronger arguments against the further extension of municipal ownership.

"It is a usual thing for any municipality to invite and encourage any business

which may bring to it capital and the employment of labor, and an action of any government which would drive from its midst such capital and such employment of labor is certainly to be deprecated. The engagement by municipalities in industries would tend to the throwing out and breaking down of any attempt on the part of capital to interest itself in the building up of a city.

"The protection of capital and the protection of labor are duties of governmental bodies far above and beyond that of any other sphere in which they may work. The destruction of capital means the destruction of labor. The protection of capital means the protection of labor. One is as much dependent upon the other as the life of plants is dependent upon the sunshine.

"If it can be reasonably demonstrated that municipal capital, wrested from the property owner and which has been acquired by him through his own exertions and toil, can be used again to his benefit, then no argument can offset it; but if, on the other hand, it can be proven, as I hope to prove, that the wrestings of the earnings of labor are to be used by political bodies for a thing which cannot result in benefit to the average taxpayer and landholder, then I say, and say positively, that no board of trustees, council, or board of supervisors controlling any district has a moral or a legal right to take that money and use it for the benefit of the few to the detriment of the many.

"Regarding municipally-conducted electric-light plants, Mr. Britton asserts that the truth with reference to their maintenance and operation has never been stated, and misrepresentations by interested employees have formed the basis of statements made to the general public. Citing the municipal electric-lighting plant of Alameda he compares it to 'a man with an income of one hundred dollars per month living upon one hundred and fifty dollars. Somebody pays for the excess of expense over receipts. If it were a clerk in commercial circles, his employer would pay for it in a surreptitious manner. In municipal circles it is the taxpayer who submits to the extra burden.'

"From reports filed by city officials, he finds that the cost of lighting the city for six years and five months has aggregated the sum of $155,223.74,—an average of $2,016.27 per month. The average number of lamps maintained for public lighting during that time, according to the report of the city electrician, has been 88. This gives an average cost per lamp per month of $22.90. According to the schedule of lighting (which is a lighting from dark until 1.30 A. M., excepting on nights when the moon is shining, and which time amounts to 117 hours per lamp per month), the average cost per lamp per hour is 19½ cents.

"I am aware that the contention will be made that it is not fair to calculate the entire cost of the plant as a basis of the cost of operation; but I submit that in a municipal plant no other basis can reasonably be employed. The cost of the operation of any municipal enterprise the taxpayers have to make up to the city in their annual payments."

Deducting present worth of plant from the total expenditure for electric lighting during the seventy-seven months in which the system has been operated, he finds that the cost has been 15 cents per lamp-hour. He then compares this cost with the cost per lamp-hour, in Oakland, Cal., where, under the management of a private corporation, it is only 6.43 cents per lamp-hour.

Assuming all construction work to stop, that no alterations will be needed, and that the expenses will remain as figured by interested employees, Mr. Britton arrives at the conclusion that even under such inconceivable conditions, the cost of lighting the streets will exceed by 75 per cent. the cost of street-lighting in any other city in the United States. If the facts are as stated by Mr. Britton, and if his calculations are correct, surely Alameda furnishes an emphatic and instructive lesson of the folly of extending municipal ownership.

Labor and Wages in China.

T. R. JERNIGAN, consul general at Shanghai, in *Consular Reports* for Janu-

ary, gives an interesting account of the status of labor and wages in China,—a country in which, among other peculiarities, the lowest wages are paid to labor, and the supply of labor is larger in proportion to the demand, than in any other country on the face of the globe. Any one endeavoring to study the limitations of that much-abused term, "necessaries of life," or desiring to solve the problem of the least cost of existence for a human being, may find aid in this paper, of which an abstract follows.

A Chinese laborer will save money on wages that would hardly be sufficient to supply the absolute necessities of an American laborer. This is made possible by the cheapness of the vegetable diet on which he is content to live, the small cost of house accommodations (several families will subdivide one room of a house, and live in contentment in it), and the low price paid for clothing, which is made of the coarsest cottons. But the cheapness of labor in China does not mean that the products of that labor are inferior in quality. The Japanese laborer, receiving higher wages, is more artistic in his work; his productions are finished, and in dyes and in the blending of colors he is superior to his Chinese rival; but in substantial and lasting quality the latter's products are fully equal, and in some instances superior, to those of the former.

There is in Chinese character a conservatism which has discouraged progress. The principle, "let well enough alone," has been adhered to under the mistaken idea that "well enough" was the best. But in China this adherence to custom, this opposition to change, has filled the empire with an impoverished population; for a people that use in their trade and business a currency of so small a denomination as one-tenth of a Mexican cent cannot be said to have felt the quickening influence of an enlarged and civilizing commerce. The cheapness and small denominations of Chinese currency, and the low price of the diet and clothing of the Chinese laborer, are evidence of non-progressiveness, but it should not be inferred from these that capacity for progress is absent from the Chinese character.

The following wages for different handicrafts in China are quoted. The symbol, F, indicates that, in addition to money, food is supplied as part of the wage. Where this is absent, no food is supplied. The wages are presented in their equivalent of United States currency.

Blacksmith, 13 cents per day (F); brassworker, 16 cents per day (F); barber, 3 cents per day (F); native bootmaker, 10 cents per day (F); foreign bootmaker, $5.28 per month (F); bamboo cabinetmaker, 11 cents per day (F); bricklayer, 10 cents per day (F); native compositor, $5.28 per month (F); foreign compositor, $7.92 to $15.84 per month (F); carpenter, 11 cents per day (F); cabinetmaker, 13 cents per day (F); coolie, 13 cents per day; native bookbinder, $4.22 per month (F); foreign bookbinder, $6.34; lithographer, $10.56; furniture polisher, 21 cents (F); native tailor, 10 cents per day (F); foreign tailor, $6.34 per month (F); pressman, $6.34 (F); native coachman, $3.17 per month (F); foreign coachman $6.34 per month (F); native house-boy, $2.11 per month (F); foreign house-boy, $4.75 (F); cotton-mill machinist, 11 cents to 22 cents per day; cotton-factory hands, 18 cents per day.

It will be seen that the practice of making food a part of compensation for labor is common; that foreign labor, without exception, gets better pay than native labor; and that foreign compositors get higher pay than laborers in any of the other occupations named. The lowest daily wages are paid to barbers, and the lowest monthly wages to native house-boys.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

†3598. German Interests in Eastern Asia. Theo. M. Stephan (Statistics of exports and imports). Consular Reports–Jan. 700 w.

†3599. European Sewing Thread in China (Extract from a report of the Austro-Hungarian consul-general, of interest to American manufac-

We supply copies of these articles. See Introductory.

turers of sewing threads). Consular Reports–Jan. 1500 w.

†3600. The Four New Treaty Ports of China (The ports described are Chungking, Hangchow, Soochow, and Sha tsze. Brief mention is also made of the Yangtze Gorges, 60 miles above Sha-tsze). Consular Reports–Jan. 2600 w.

†3601. Labor and Wages in China (The lowest wages paid in any known country prevail in China. The labor supply is also more abundant than in any other land. Notwithstanding this, in utility and lasting qualities, Chinese manufactures take a high rank. The causes of these peculiarities are interestingly discussed). Consular Reports–Jan. 1500 w.

3616. Movement of Prices (A review of prices from the close of 1890 to the beginning of 1896, including an important table of comparative prices of 109 staple articles, raw and manufactured products, produce, cattle and meats, at quarterly intervals, showing fluctuations in quotations from the close of 1890 to Jan. 1, 1896, covering the period of recent extreme depression). Bradstreet's–Jan. 11. 1800 w.

3712. Municipal Ownership of Electric Light Plants. John A. Britton (A powerful argument against the moral and legal right to wrest the property of electric light plants, or other analogous property from their present ownership, and claiming that in the case of electric light plants, the maintenance would be increased 75% under municipal control). Am Gas Lgt Jour–Jan. 20. 4800 w.

†3724. Business Men and Social Theorists. C. R. Henderson (The great prizes in this country are not found in Congress, literature, law or medicine, but in business. The peculiar type of manhood developed by this condition is the principal theme of this paper). Am Jour of Soc–Jan. 5000 w.

†1725. The Province of Sociology. George E. Vincent (Syllabus of a course occupying four hours per week during twelve weeks: given by the author at the University of Chicago in the autumn quarter, 1895). Am Jour of Soc–Jan. 6400 w.

*3798. In the Cause of Good Government (Editorial review of an able address delivered by the rector of the Edinburgh University, which enforces the duty of practical politics upon every member of society who desires the reform of social relations, especially those relating to industrial activities). Jour Gas Lgt–Jan 14. 2000 w.

3805. A Unique Statistical Experiment (The preparation of this article, and the tabulated statement accompanying it, have involved an enormous amount of labor. It is an analysis of the correctness of business ratings, according to the system of the Bradstreet Co., the basis being the records of success or failure of those thus rated through a considerable period. Many valuable lessons in industrial sociology may be derived from a study of these statistics and in connection with the financial history of the period covered). Bradstreet's–Jan. 25. 5000 w.

*3815. The Industrial Condition of the South before 1860. Richard H. Edmonds (Historical review with statements tending to prove that the industrial condition of the south has been misrepresented, and that previous to the war it was quite abreast with the times). Chau–Feb. 5000 w.

*3840. Our Monetary Programme. J. Laurence Laughlin (The writer holds that the cause of all our monetary disturbances is not one connected with the medium of exchange, but one concerning the maintenance of a definite measure in which prices and contracts are expressed). Forum–Feb. 7000 w.

†3843. Why Gold Goes Abroad. A. C. Fisk (The writer finds an answer to the question in an examination and analysis of the government reports of exports and imports. He finds the remedy in a silver basis, or one-hundred cent dollar basis). New Sci Rev–Jan. 2500 w.

*3845. Customs Tariff of New Zealand (Table of duties now in force since the revision under an act passed Oct. 18, 1895). Bd of Tr Jour–Jan. Serial. 1st part. 1200 w.

*3846. Tariff Changes and Customs Regulations (Includes changes in tariffs and customs regulations throughout the world). Bd of Tr Jour–Jan. 6000 w.

*3847. New Currency in Porto Rico (Circulation of Mexican dollars forbidden. A special coinage will be issued under Royal Decree, with authorized circulation in Spain). Bd of Tr Jour–Jan. 500 w.

*3860. Tariff Reductions and Fiat Money. Raymond E. Dodge (An argument in favor of establishing a United States Bank, and the extinction of fiat money; the position being taken that the latter is attended with dangers that can only be guarded against by the establishment of the former). Gunton's Mag–Feb. 2400 w.

*3861. The American Federation of Labor (Editorial review of the proceedings of the fifteenth annual convention of this organization, held in New York Dec. 9 to 17, 1895. It is regarded as the leading radical society on this hemisphere, and as having a great future before it). Gunton's Mag–Feb. 1300 w.

*3862. Compulsory Arbitration. Jerome Dowd (A socialistic argument for more extended state control of labor; the state to fix wages in many employments, and to forbid workmen quitting their work at their own option. State regulation of prices and rates of transportation are also advocated to an extent rendering the individual nothing, and the state everything). Gunton's Mag–Feb. 2200 w.

†3913. The Increased Production of Gold. Edward Atkinson (Differences in conditions under which our modern supply of gold are obtained as compared with former years are noted, and an effort to present data for a forecast of the effect of the great annual additions to the world's stock of gold is essayed. The argument is based upon the assumption that the world's commercial unit of value is now fully and finally established, and that it is a fixed weight of gold, whether in ingots or coins made from ingots. The position is also taken that the United States holds command over all the gold resources of the world, and the dominant control of iron, steel

and copper. The demand debt of the United States should be paid without forced loans, and legal tender notes paid in coin should not be reissued). N. Amer Rev–Feb. 5500 w.

*3925. Shall the American Home Be Saved? William S Beard (An examination of the question whether or not the American nation is on the upward trend, based on the condition of the unit of nationality, the family; this condition being determined from available evidence. The conclusion is reached that the condition of American homes is on the average, deteriorating and is approaching a destitution of general well-being; and that hence the ravages of civil decay have already begun in American institutions). Am Mag of Civ–Feb. 5200 w.

*3926. Proportional Representation: A Remedy for Municipal Misrule. J. Eugene Whitney (Paper presented at meeting of New York State Commissioners on City charters. The thesis is that while in theory our government, municipal, state and national, is founded upon a representative system, it is not so in fact, and the argument is directed to the support of this proposition. Glaring evils of our system in its practical operation are noted. Unless proportional representation in fact as well as in theory be restored, these evils will persist and increase). Am Mag of Civ–Feb. 2300 w.

*3927. The Labor Problem. Nelson Baldwin (The first part discusses the growing evil of tramps, and traces it to want of sufficient employment to keep available labor busy. Labor's share of the products of labor is considered as too small. The question of how demand for labor can be increased is also discussed, and monopoly is charged with being the greatest enemy of labor). Am Mag of Civ–Feb. Serial. 1st part. 3200 w.

*3928. The Silver Question, Jay Cooke, in the *Investment News* (The act of 1873, demonetizing silver, is held to have been ignorantly legislated, and ignorantly signed by the president. Its results are held to have been disastrous. The silver question is treated as of supreme importance to the United States, and the salvation of the country is regarded as conditioned upon a return to bimetallism). Am Mag of Civ–Feb. 2200 w.

*3930. The Ethics of Trade and Capital as Related to Popular Government. David Allyn Gorton (The evils resulitng from inequality and which have cursed the old world, are held to be developing in the new. The paper is an argument and protest against this inequality. Capital and labor are regarded as warring against each other. The growing need of a standing army to keep peace between the rich and the poor, is one of the rather ultra assertions made by the writer). Am Mag of Civ–Feb. 4500 w.

*3931. The Education of the Negro. J. L. M. Curry (The process of educating the negro element of our population is of necessity slow, but the progress so far made, if it can be called progress at all, is so meagre that the author evidently does not hope for much ultimate improvement in the Afro-American status). Am Mag of Civ–Feb. 5000 w.

*3936. Some Leading Errors of the Gold Standard Party. Otto Arendt. Translated by E. Benj. Andrews (This article first appeared in the *Deutcher Wochenblatt*. Though primarily intended to refute certain views put forward in the *Silesian Times*, it is of general interest. It is a strong argument favoring bimetallism). Rev of Rev–Feb. 3500 w.

*3937. Bimetallism: Some Damaging Facts in Its History. Frank Irving Herriott (Review of the History of Currency, by Mr. W. A. Shaw, and Money and Banking, by Horace White, of the New York *Evening Post*). Rev of Rev–Feb. 3000 w.

4007. Proposed Changes in the Patent Laws (Editorial. An able and just criticism of some of the proposed changes in the United States patent laws now under consideration by the House Committee on Patents. Lurking dangers are pointed out, particularly the claus· of the bill providing for the termination of a patent by act of Congress). Ir Age–Feb. 6. 1800 w.

4033. Wealth and Finance Statistics for a Century (Statistics compiled from the last bulletin of the Department of Labor). Bradstreet's–Feb. 8. 1400 w.

4034. Reforming Speculation in Grain (The new so called Lindblom plan, named from its originater, explained, and a scheme for its organization set forth. Under this plan sales are to be followed by immediate delivery, which, it is assumed, will exterminate bucket shops. The present prospect is that this plan will be adopted, and that an anti-option bill will follow in due time). Bradstreet's–Feb. 8. 1100 w.

4035. The Silver Senate (The supremacy of the silver men in the United States Senate is considered as demonstrated by recent legislation, but its mischievous effects are likely to be warded off so long as present conditions remain at the seat of government. The non-concurrence of the House and the antagonism of the President will, for the present, at least, be efficient obstacles to action of the Senate). Bradstreet's–Feb. 8. 700 w.

4040. Capital and Labor. R. H. Hadfield (Results of experience in an extensive English steel works. The effort to get employers and employed on a better footing is urged as a possible solution of many differences between them). Eng & Min Jour–Feb. 8. 2200 w.

†4065. Infantile Life Insurance in Europe. C. W. Chancellor (The system, at the present time forcing itself upon the American public, is disapproved, having shown itself in Europe to hold out inducements among the evil minded to parental neglect, cruelty, and even crime). San–Feb. 2000 w.

*4078. Our Unused Surplus. Charles H. Smith (From an address delivered before the annual meeting of the Mich. State Millers' Assn. Discusses obstacles to increased foreign demand for American flour and urges the putting aside of partisan prejudices and a common effort directed to the extension of our foreign trade not only in flour but in other lines of manufacture). Am Miller–Feb. 2000 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Shipping on the Great American Lakes.

AMONG the mass of information relating to the marine traffic on the North American lakes, presented in interesting form by Mr. Henry S. Pickards, in *Yale Scientific Monthly* for February, we single out for this review the topic of naval construction. The progress made in western shipbuilding is beginning to attract the serious attention of shipbuilders at other points, and even in England, where ships have been turned out at lower cost than in any other land. The possible development of a shipbuilding industry on the shores of the American lakes that will successfully compete with, and become a powerful rival of, English marine engineering and construction has already excited apprehension in Great Britain. In the industry as it now stands, Cleveland, Ohio, seems to be taking the lead. Mr. Pickards says that "some of the largest and finest of the lake carriers are built in Cleveland, at which port are built ships aggregating greater tonnage than any other port in the world. The modern lake carrier is not surpassed, except in size, by anything afloat. The two passenger steamers built in 1895 by the Globe Iron Works Co., of Cleveland, for the Northern Steamship Co., are as fine in construction and equipment as any ocean ship. As floating hotels, they rival the great trans-Atlantic liners. They are each three hundred and eighty-five feet long and capable of a speed of twenty miles per hour. Schedule time is made between Buffalo and Duluth in connection with the Great Northern Railroad.

"The peculiar conditions existing on the lakes, due to shallow passages and bulk freight, has brought out much ingenuity in the construction of ships. The Whaleback—or pig, as it is more familiarly called from its peculiar appearance—is distinctly a lake type of vessel, although a few ships of this model have been taken to salt water. It was invented by Capt. Alex. McDougall, and many ships of this class have been built by the American Steel Barge Co. at West Superior, Wis. For carrying capacity on a limited draught, and economy of construction and operation, they are very successful. The monitor is a type of ship following somewhat the lines of the 'whaleback,' and possessing some of its advantages.

"The straight-back is another style of construction coming into favor. It is not very different from the ordinary lake steamer, except that, as the name implies, it has a straight back having no sheer whatever, which somewhat cheapens the cost of construction.

"But most of the freight is still carried in the ordinary steamer, whose principal point of difference from an ocean ship lies in the position of the engines, which are placed well aft, affording greater facility for loading and unloading. Several large ships have lately been built on the ocean model with the engines amidships, which keeps the bow down, and improves the steering qualities in a head wind, when the ship is light. As most of the large carriers prefer to go light from the lower lakes to the ore-shipping ports, rather than to carry coal and be detained by the loading and unloading, this is an important consideration. However, this type of ship has found little favor on the lakes, and few of them have been built.

"The tow barge also plays an important part in lake commerce. In former years it was not uncommon to see a steamer towing four or five old schooners up the lakes at a rate of five or six miles an hour. Then the new steamers found that much better time could be made by running alone, and for a time the tow barge seemed to fall into disfavor, only the poorest class of ships being found in this service. The introduction of the 'whaleback,' however, and the economy with which a fleet of steamers and two or three barges could be operated, and the large

cargoes which they accommodated, caused a revival of towing, and now many large steel schooners are coming into use, and are towed by some of the largest and fastest of the lake freighters.

"In this same line comes an entirely new departure, which is the result of the enterprise of the Cleveland Steel Canal Boat Company, which has built and put into operation a fleet of canal boats of such type that they are amply large and strong to navigate Lake Erie in good weather, and also of such size that they are able to pass through the Erie canal. They are thus able to load freight on the lower lakes and deliver it in New York without breaking bulk, and to bring sugar and other slow freight back under the same conditions. This has a tendency to remove the center of eastward canal shipment from Buffalo, and to distribute it among the other Lake Erie ports. The large steel plant at Lorain, Ohio, has shipped one large consignment of steel rails to New York by this route. The success of this venture is amply proven by the fact that the company has placed an order for three steamers and ten barges, which will increase the capacity of the fleet three fold. The building of these boats on salt water, at the end of the route, indicates no dissatisfaction with those already built, but that the yards on the lakes are so busy that there was doubt as to the time when they would be ready for service, and also that the company desired to have one fleet ready to start from each end of the line at the opening of navigation, the present fleet having been laid up on the lakes." This rush in the lake ship-yards is in strong contrast with the recent stagnation in ship-yards abroad.

The Submarine Boat "Le Goubet," No. 2.

WE herewith present an abstract of an illustrated description of this, one of the most successful submarine boats yet produced (reprinted from *La Nature* in *Electrical Review* of Jan. 10).

The shape of the boat is that of a spindle formed by the revolution of an arc turning on its chord. The regularity of its outline is interrupted at the top by a dome or oval lid which opens to give access to the interior, and at the bottom by a kind of false keel which, while imparting exceptional stability to the apparatus, constitutes a safeguard in cases of unforeseen emergency. Upon one turn of a key being given by one of the staff, this weight is detached, leaving the floating part, thus suddenly lightened, to rise to the surface of the water like a cork.

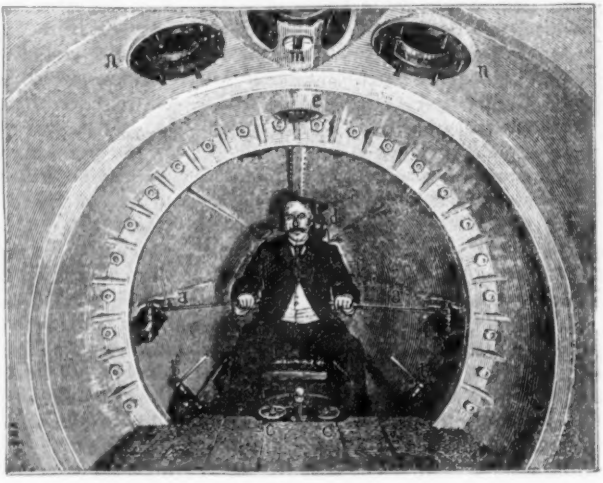


FIG. 1.

In the horizontal middle plane two thin wings run from end to end of the boat, contracting the rolling movement, and serving as a support to the self-propelled torpedoes which the boat carries when required. The port holes are distributed at equal height along the shell, and on the top of the dome. "Le Goubet" No. 2 measures 8 meters in length, and has a diameter of 1.75 meters at the row-locks. It weighs about 10 tons, and it can be taken apart into three pieces, which are

held together by inner collars securely bolted. The false keel alone weighs 1,200 kilograms.

Whereas in the first boat there was a little want of space, the two men forming the crew being obliged to sit back to back just in the axis of the ship, the new type is more roomy in the middle; the captain can take his place on a revolving seat, which enables him to look out through the port-holes in the dome, and the two sailors who assist him are seated at the two extremities, opposite one another, each having within reach the controlling appliances required for his work.

The man who works the oars (Fig. 1) has in front of him the handles, *a*, *a*, a fact which enables him to open upon the sea the outlet of the pump, the taps of which are *b*, *b*, and to expel (as required, and according to the position of the valves, the wheels of which are seen at *c*, *c*,) the water, which serves as ballast, or the vitiated air, which, owing to the density of the carbonic acid, is condensed in the bottom of the boat. Behind his head, at *d*, is the "postal" apparatus, the cavity of which may be either opened for the placing in it of the little water-tight case containing despatches, or put in communication with a vertical chimney opening into the sea when the case rises to the surface of the water by its own specific lightness. The fore-part of the vessel also contains the steel tubes, holding the reserve stock of respirable air.

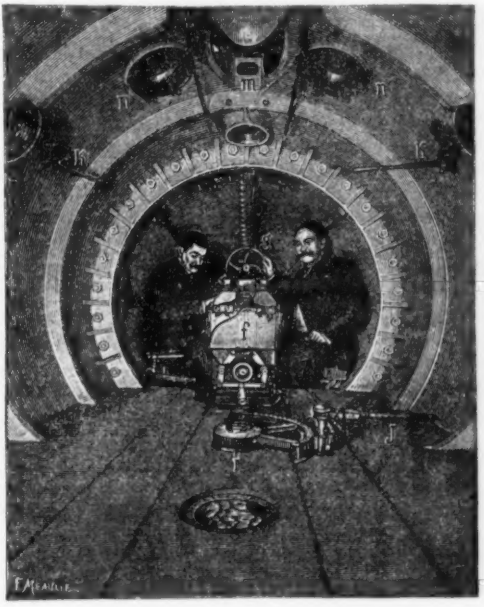


FIG. 2.

The electromotor is in the stern (Fig. 2). On the inner sides of the shell are bolts for setting free torpedoes, shown in the same figure. On the floor (Fig. 2) is shown the handle which gives a quarter of a turn to a bayonet hinge that keeps the false keel in position; this quarter of a turn is sufficient to detach this safeguard, and thus set free the floating part, which at once rises to the surface.

In the normal state the little vessel floats on the surface of the water, only the dome appearing above. The captain, by looking through the port-holes that are out of the water, can sweep the horizon and steer at his ease. It is very difficult to perceive from a distance this floating part, which is no bigger than a life-buoy. Only when it enters the zone of danger does the real work of the submarine vessel begin. A little water being introduced into the bottom of the vessel, it is submerged to the required depth (4 or 5 meters generally; 10 meters, if necessary).

When it is thus submerged, objects above water are seen by means of an optical tube passed through the bronze shell and reaching to the surface. Ingenious arrangement of water ballast enables the boat to keep at the desired depth of submergence. The motive power is supplied by a bisulphate of mercury battery, without use of accumulators. A speed of from four to five knots per hour is said to be easily realizable.

Care of Marine Boilers.

THE care of the modern marine boiler is discussed by F. W. Kincaidy, passed assistant engineer U. S. N., in *American Machinist* (Feb. 6). The advantages of heating feed-water by heat derived from the uptake, and of maintaining a supply of fresh water through the use of evaporators, are urged. The advantage of heating feed-water, even when the heat of the uptake is not utilized for this purpose, has generally been conceded. Its effect upon the durability of marine boilers is marked, and the cost of repairs due to leakage, etc., is lessened. Engineers are apt to neglect evaporators, and, on thewhole, the supply of fresh water is not of so great importance as properly heating the feed water.

"As a matter of fact, even when evaporators are fitted to ships, their existence is often ignored by the chief engineer, who is apt to look upon these things as unmitigated nuisances. If he wants to make up feed, he uses salt feed; and, it must be confessed, if his internal feed-pipes are properly arranged, there is no harmful result. If the feed-water, after passing the check valve, is led through, say, twenty feet of internal piping, and then allowed to mingle with the surface water of the boiler, we have then an arrangement which constitutes the boiler its own feed-heater. The sulphate of lime is precipitated in the body of the water (whose temperature, with steam of 160 pounds' pressure, is about 371 degrees F.) before it has time to reach any of the heating surfaces, and the result is a boiler free from leaks and scale, and absolutely clean, with the exception of a little mud in the bottom, which can be blown out.

"Live steam heaters, with removable pans for catching the scale, are sometimes fitted over marine boilers, the heated and purified feed entering the boiler by gravity. Such an arrangement is to be recommended in the case of water-tube boilers, where it is inconvenient or impossible to fit internal feed-pipes."

The Engineers' Strike at Belfast and on the Clyde.

ENGINEERING (London, Feb. 7) says that the great lock-out, and strike at Belfast and on the Clyde has ended, and the men, as far as practicable, have resumed work. It naturally takes a little time to settle down, each in his own place, after a stoppage extending over months, but it appears that the resumption of work has been as general as could have been expected. In Belfast there were the further difficulties with the ironfounders, and with the brassfounders and brass-workers, but these seem also to have been arranged. The question of the apprentices also had caused some friction, but the matter has been arranged. Some inconsiderate persons have been calling in question the right of the council of the Engineers to bring pressure to bear upon their Belfast members to induce them to return to work. The council may be left to justify their own action as regards the technicalities of their rules, but on general grounds the council of a society have always exercised pressure when circumstances indicated the necessity. And, as a rule, the society generally has supported such action, in spite of severe condemnation on the part of a small but noisy clique. Instances could be cited in which the engineers, boilermakers and iron ship builders, carpenters and joiners, ironfounders, and others, have exercised such pressure with advantage. The council is not likely to interfere recklessly. The question is one needing the most tactful and considerate treatment, and before touching it, great caution will doubtless be exercised.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*3594. Water-Tube Boilers. J. D'Allest (Criticism of a communication to *Engineering*, by Messrs. Maudslay, Sons and Field, called out by a paper of John K. Robison, U. S. N., purporting to give conclusions derived from personal observations of water-tube boilers in the French Marine). Engng-Jan. 3. 1800 w.

*3595. Sir Edward J. Harland (Obituary

We supply copies of these articles. See introductory.

Gives an account of the life and work of one of the most famous English naval architects). Engng-Jan. 3. 6700 w.

†3602. The Port of Shanghai and China's Trade (Details the companies and vessels which trade at this important port and predicts that the future route to China, either with or without the Nicaragua Canal, will be across the Pacific). Consular Reports-Jan. 2200 w.

*3658. List of Vessels Launched in 1895 (Purports to be a complete list of new vessels set afloat from all yards in the world during 1895, with names of owners, material of construction (steel, wood, etc.) class names of the vessels, and nominal horse-power). Marine Eng-Jan. 1. 15000 w.

*3659. Summary of Shipbuilding Returns of United Kingdom in 1895, Arranged in Order of Tonnage, Built by Each Firm (A useful table for reference. Seventy establishments are listed). Marine Eng-Jan. 1. 300 w.

3666. Present Strength of the New United States Navy (A list of the United States warships with brief descriptions, and two page illustrations, showing comparative dimensions of forty of them). Sci Am Sup-Jan. 18. 2000 w.

*3684. The Submarine Boat "La Goubet." From *La Nature*. G. E. (Illustrated description of a torpedo boat, named for the inventor). Elec Rev, Lond-Jan. 10. 2000 w.

*3735. The Stranding of French Ironclads (Full account of the grounding of the Formidable and two other ships of the French navy, the cause of the accident and their rapid and skillful extrication from a perilous position, with a picture and a map of the harbor of Badines, where the incident occurred). Engng-Jan. 10. 4000 w.

*3754. Submarine Navigation. John P. Holland (Abstract from a lecture delivered before students of Sibley College. An able and exhaustive discussion of the principles of submarine navigation and construction, showing very plainly the differences between these principles and those applicable to floating vessels, whence arise many difficulties which have been gradually surmounted in the progress of the art. An exceedingly interesting paper). Sib Jour of Engng-Jan. 6500 w.

*3827. Naval Architecture—A Few Principles Popularly Explained (First part deals with displacement, illustrating the text by diagrams, and employing only simple equations of the first degree). Eng, Lond-Jan. 17. Serial. 1st part. 2200 w.

*3836. Transatlantic Navigation. R. C. Lanphier (Historical. Beginning with the earliest attempts of steam propulsion, the account is brought down to date). Yale Sci M-Jan. 6500 w.

*3837. Recent Developments in Torpedo Boat Construction. F. S. North (Deals with modern torpedo boats, their operations in the late China-Japanese war, their requirements, etc.). Yale Sci M-Jan. 1600 w.

3858. The Timber Dry Dock No. 3 at the New York Navy Yard (Popular description with views of the work in progress). Sci Am-Feb. 1. 1100 w.

3874. A Condensed Engine. Ill. (A remarkable and curious steam engine design by Mr. Frank Cary, Penn Yan, N. Y., with low centre of gravity and singular compactness). Am Mach-Jan. 30. 800 w.

†3915. The Mysterious Wreck of Nemi. Rodolpho Lanciani (Describes the discovery and the attempts at lifting the wreck of a large ancient vessel. Such portions as have been recovered show a knowledge of the art of naval architecture, dating back to the classic period of Roman history, very much in advance of what has been commonly supposed). N Amer Rev-Feb. 4000 w.

*3943. The World's Principal War Fleets (A review of development of war vessels from earliest times to date, and of the present military marine of the entire world). Eng, Lond-Jan. 24. 5500 w.

*3950. Birmingham and Bristol Channel (Illustrated brief description). Eng, Lond-Jan. 24. 1000 w.

*3954. Water-Tube Boilers (An interesting continuation of the debate upon circulation in water-tube boilers, in which four correspondents take part). Engng-Jan. 24. 3800 w.

3987. Steam Plants of the St. Paul and St. Louis (Illustrated detailed description). Power-Feb. 2500 w.

4011. Care of the Modern Marine Boiler. T. W. Kincaidy (A practical paper). Am Mach-Feb. 6. 500 w.

4031. The Reorganization of the Engineer Corps of the Navy. Ira N. Hollis (A critical analysis and review of the bill for reorganizing the engineer corps of the United States Navy. The first part discusses the proposed increase in the number of commissioned engineers; duties of engineer on shore and at sea; the necessity for higher standards of skill to keep pace with advances in marine engineering; the lack of marine knowledge usual with secretaries of the navy; their liability to be deceived by men with more tongue than talent, and the consequent thwarting of the efforts of able engineers to improve the efficiency of the service, and other matters of present interest and importance). R R Gaz-Feb. 7. Serial. 1st part. 3500 w.

*4043. Shipping on the Great Lakes. Henry S. Pickands (Illustrated account of the industry and improvements in marine engineering, especially as manifested on the Great Lakes). Yale Sci M-Feb. 2800 w.

†4057. A Rubber Boat that Crossed the Sea. From *Harper's Weekly* (Description of a novel boat, the invention of E. L. Perry, which carried three men across the Atlantic nearly 29 yrs. ago). Ind Rub Wld-Feb. 10. 500 w.

†4066. The Relation of Naval Architecture to Proper Sanitation. J. R. Tyron (An important and able discussion of effective and defective sanitation of ships, reprinted from the annual report to the United States Navy. The question of naval construction as bearing upon sanitation, is exhaustively reviewed). San-Feb. 13000 w.

MECHANICAL ENGINEERING

Accuracy in Workmanship.

AN editorial in *The Engineer* (London, Jan. 24) begins with the following paragraph:

"Of the thousands of engineering firms all over the globe, the number which insist on a close approximation to accuracy of work might be expressed in two figures; yet the other firms, which are content with less perfect work, turn out machinery which performs its duties satisfactorily, and even in certain cases with great efficiency. It is not an uninteresting investigation, then, to look into the conditions which decide the particular degree of excellence which is most desirable in mechanical construction, and to attempt to arrive at a conclusion which may to some extent be capable of general application."

In this attempt the writer has undertaken a difficult task. The subject must be viewed from the standpoints of both the manufacturer and the purchaser; and that these are apt to differ very widely goes without saying. The purchaser, having agreed upon a certain price for a special construction, wants as good work as can be produced within the limits of the specifications upon which the contract is based. The manufacturer, while he generally desires the work to be creditable to his reputation, naturally objects to refinements which he thinks unnecessary to the proper working of the machine or appliance he has agreed to supply. He keeps at least one eye on his prospective profits, and, in our opinion, is justified in constantly regarding the profits, so long as he executes the letter and spirit of his agreement. He is not in business for his health any more than is the purchaser. The right of the purchaser to get as good work as he can for his money, and the right of the manufacturer to make as large a legitimate and honest profit on a job as he can, must both be conceded, but these rights, being forces operating in opposite directions, are liable to lead to disturbance, unless they are balanced with exactness by the terms of the agreement.

We reach a different phase of the subject in the case of the manufacturer who, having decided what price he can judiciously place on the machines or appliances he is placing on the general market, seeks to fix upon such a degree of finish and accurate workmanship as will insure successful operation and good sales, and at the same time leave a satisfactory margin of profit.

It is this phase with which the article quoted deals more particularly, and, as we think, not very satisfactorily; for, beyond the already well-recognized principle "that in the long run a high degree of accuracy pays well" in the manufacture of large quantities of any specialty, no conclusion which may to any extent "be capable of general application" appears to have been reached. At the same time, the difficulty, if not impossibility, of formulating any generalization for a matter that, in its very nature, depends upon individual judgment must be recognized.

Nevertheless, this article contains many valuable hints upon a subject of ever-present interest. The question, which is a simple one to the purchaser, is complex enough when viewed from the manufacturer's stand point.

"Putting aside for the moment the moral effect of the standard of work on his men, he has to take into account (1) the number of similar articles required; (2) the probability of future orders; (3) the cost of the necessary tools, both in outlay and in wear-and-tear discount; (4) the increase or decrease of highly-skilled labor; (5) the time of manufacture; (6) the conditions affecting his particular case, as shop space, standard efficiency of staff, etc. We have put the number of similar articles required and the probability of future orders in the first place, because, provided these be sufficiently high, they overweigh all other considerations. We are

well aware that there are still many manufacturers turning out large quantities of machinery identical in all parts, who do not insist on a high standard of excellence. There can be little question that this is false economy. The necessary outlay in tools may mean drawing a considerable sum from the capital, but it will be returned in the increased facility of manufacture. Let us explain this more fully; and, for the sake of example, we will take the case of a large number of small steam-engine cylinders, all made from the same drawings. The quantity actually on order at any time, it should be observed, does not affect the question, if the probability of future similar orders is considerable, or if the price for the first lot is sufficient to partly cover the expense of the tools. The maker who is not prepared to work accurately planes up one cylinder end, bolts the cylinder on to a face plate, and bores it out with a simple tool. His lathe probably is not in the best condition, or made by the best maker. Consequently, his cylinder is a little taper and considerably elliptical, perhaps to the amount of several hundredths of an inch. His cylinder covers have in the meantime been turned and the stuffing-box bored; he prefers probably to leave his piston until he can gage the cylinder with an indifferent pair of callipers and turn it to fit the smaller diameter. The holes for the cover studs have been marked off with compasses, or at best with a plate template, and drilled with a shaky drill through the cover. These holes are scribered through on to the cylinder ends, and the tapping holes drilled, as accurately as a man can judge by his eye, concentrically with the clearance holes scribered on. They are then tapped by hand. Again, he chips out his ports to scriber lines, and makes his valve in the same way. It is unnecessary to go further. What is the result of all this ramshackle work? The cylinder has to be scraped out true, and the covers adjusted to the position in which the rods work through them best. Some studs are not vertical, and have to be knocked straight; others fit too tight or too loose in their holes; others are not in the right position, and the cover holes have to be filed out to suit. Tedious complications occur with the valve, and so on and so on. How much simpler are the same operations as performed by the best maker? The cylinder is held steady and two cuts taken through with long cutting tools gaged to a thousandth of an inch over the edges, and the ends faced from the boring bar. The stud holes are drilled from cast-iron copies through holes bushed with hard steel, and are tapped and studded in a machine that insures fit and verticalness; the ports are milled out to a hard steel copy also. And so with the corresponding parts. What is the result? The engine can be put together, and work without hitch in one-fifth the time the other takes. Through all the remaining details the same class of work is carried out. Fitting is reduced to a minimum; it is merely the putting together of parts which are gage fits. But where fitting has to be done the same accuracy is observed; faces are scraped, not merely filed, and holes made gage-size and drilled through jigs, and all boring and turning done to fixed callipers or bar gages. It is evident, therefore, that the superior maker can reduce slightly his number of highly-skilled hands, though it must be borne in mind that a certain number taken from the fitting shop must be transferred to the tool shop and charged solely with the upkeep of all the accurate tools, templates, jigs, etc. On this point, then, he does not gain much, if at all, and on the original outlay on tools he is considerably the loser. For really accurate work no feature is of nearly so great importance as the condition of the machine tools; and of all the tools the lathes and milling machines require the greatest perfection and the tenderest care. No one who has not had practical experience of tools of different qualities can fully appreciate the vast difference between even a good tool and a perfect one. The manufacturer's outlay on tools must be very high, for he must have the very best tools, keep them in the best condition, and employ good workmen on them. We fancy this one of the principal obstacles to great accuracy of work

in already established firms. They are not prepared to go to the expense of large new plants, and they find they are totally unable to work to a fraction of a thousandth of an inch with their existing tools, so give up trying for a 'fit' at all."

Increasing the Heating Surfaces of Boilers.

A FALLACY that misleads many designers of boilers who are not fully versed in the principles that govern the transmission of heat is well dealt with by Mr. F F. Hemenway in *American Machinist* (Jan. 30). This fallacy is that a large heating surface necessarily and of itself is almost sufficient to make a good, economical boiler. Many even make the mistake of giving this feature of a boiler so paramount importance that they sacrifice other essential features to gain the large surface, and then are surprised to find that, after all, they have an inferior or worthless design. This mistake is not made by trained engineers familiar with the action of heat in generating vapors from liquids; but unfortunately, within the last few years, a host of designs—especially of boilers for heating buildings—have been made by men who knew little or nothing of the physics of steam production, and who have seized upon the one idea of large heating surface as the principal thing needful in boiler construction. In the advertisements of these makers the words "heating surface" and the figures representing it are printed in large type, and other things no less important are overshadowed.

Mr. Hemenway does a timely service to the public by his criticism of this fallacy. Unless heating surface be judiciously placed with reference to grate, and properly proportioned to the grate surface and the smoke-flue,—in short, if the dependence of each detail upon every other, and the law of this dependence, be not recognized,—nine out of ten such designs will fail of good results, and the few cases wherein some measure of success is reached will be purely accidental. Mr. Hemenway says:

"It is not always the added heating surface that is to be objected to, but the manner in which it is obtained. But the additional heating surface is not always desirable. I have reasons for remembering the test of a steam engine, three boilers being used for supplying steam. The first result of the test was not satisfactory, and on the second day one of the boilers was cut out, when what was desired was obtained, notwithstanding the reduction of heating surface.

"Some ten years or more ago it was essayed to put a wonderful 'economizer' on the market; big stock company, and all that. There was so much pipe about the arrangement that you had to trust to imagination as to the location and general shape of the boiler; and, by the way, there must be a good many pipes in order to materially increase the heating surface. I never heard of it after it had been applied to two boilers. I only knew that I incurred the lasting enmity of one of its promoters by venturing to say a word as to what I thought objectionable about it, particularly the vast array of pipe joints exposed to high temperature.

"If you have a boiler that permits the gases to escape at too high temperature, the remedy—and in the end it is likely to prove the cheapest remedy—is to buy a new one, bearing in mind that heat is necessary for producing chimney draft, as well as for imparting heat to water; and, in any event, no important change should be made in a boiler, except by advice of a competent engineer known to be reliable and disinterested."

The Design and Testing of Fans.

IN a paper by Messrs. H. Heenan and W. Gilbert, according to an abstract printed in *Machinery* (London, Jan. 15), experiments are described which were directed to the determination of the best form of fan-blade, and fan-case, and the most economical diameter and speed of fan, for moving any required volume of air at a given pressure. After reference to some of the practical difficulties involved, an outline is given of the manner in which the performance of a fan should be tested, a blast fan 28 in. in diameter being selected for illustration. A distinction is made between

velocity and pressure gages for various deliveries, and the method of drawing the characteristic curve is explained. The effect of the variation in the shape of the blades is next studied, those chosen having tip angles of 35 deg., 60 deg., and 90 deg., respectively, the fan centre being 17 in. in diameter. It was shown that the radial blade gave the best result.

The experimental apparatus used for testing the smaller classes of fans is described. Each fan delivered air through a circular iron tube into a boiler flue 2 ft. 6 in., in diameter and 18 ft., long. Circular orifices of various sizes were fitted in the flue to form graduated resistances, and the air-velocity was estimated by an anemometer at the open end of the flue. A transmission dynamometer measured the power absorbed by the fan. It was remarked that considerable differences in the velocity of the air might exist at the same cross-section of the delivery-tube of the fan, in proof of which drawings were exhibited of the curves determined by experiment and of those obtained from some of the fans tested.

The Heenan mine-ventilating fan, tested at Parkend Collieries, had a fan-center of 7 ft. in diameter and 2 ft. in width. This fan was designed to pass 20,000 cu. ft. of air per minute at a water-gage of 3½ in., and the result was found to agree well with the rules developed by the authors. A variable resistance was provided by closing the mouth of the air-drift to a greater or less extent. The horse power given to the fan was obtained by indicating the engine. Characteristic curves for tip-speeds of 5,000 ft., 6,000 ft., 8,000 ft., and 9,000 ft. per minute were given. The maximum efficiency was 70.3 per cent.

The comparative output of fans of the same type, but differing in size, showed that, if they were run at the same tip speed, and at the same pressure shown by water-gage, the air-discharge would be proportional to the center section of the fan,—that is, to the diameter multiplied by the width. This being so, if the air discharged from any fan and the corresponding brake horse-power be divided by the area of the center section, the characteristic curves plotted from these data, with the observed water-gage, will be the same for all sizes of fans of the same type. It was shown that the dimensions of a fan could be determined from these curves, so that the most economical results may be obtained; and an apparatus was described by means of which the accuracy of the water-gage tips, used for the measurement of air pressure and velocity, was tested. To test the facing gages the following method was adopted. The tip was moved at a known velocity through air at rest, by causing it to describe a circle 20 ft. in circumference, and provision was made whereby a water gage recorded the air pressure set up. The pressure in feet of air due to velocity in feet per second was obtained by dividing the square of that velocity by 64.4; and it was found that a facing-tip, whether conical, parallel, or bell-mouthed, when used in connection with a water-gage, would record this amount correctly. Three side-tips, which had been used to determine the compression existing in a stream of air flowing through a pipe by placing them at right angles to the direction of the flow, were next tested.

The object was to determine how far these tips were affected by induction. Two of the tips consisted of pieces of pipe, ¼-in. bore, and having an external diameter of $\frac{5}{16}$ in. and ½ in. respectively. It was found that, owing to induction, the pressure recorded was less than the correct amount by a quantity equal to 45 per cent. of the gage-reading, which would represent the velocity of the air-stream in question. The third side-tip had a plate 2 in. in diameter screwed to the end of the pipe, the edge of the plate being bevelled. The readings of this gage were found to be correct, and it was used in all experiments recorded in the paper. The tip-speeds used varied between 60 ft. and 190 ft. per second. A series of tests made to determine the efficiency of an expending chimney were then recorded. Air was passed from a fan through a delivery-tube into an expanding chimney, the sides of which could be set at any desired angle to the center line of the tube. The efficiency for any angle was obtained by dividing

the vacuum observed at the throat of the chimney by the calculated vacuum due to the reduction of velocity of the air as it passed from the inlet to the outlet of the chimney.

Electric Arc Welding.

AN interesting historical sketch of the rise and progress of the art of electric welding is presented by Mr. William Handy in *Electric Power* for January. Attention is given in this paper more particularly to electric arc welding. The Benardos system comes in for a large share of notice, and the description of examples of work done by this system are interesting. Mr. Handy says:

"A steel roll, in which the wobbler end has become so much worn that the coupling box turned round without driving it, was taken out, and the damaged corners built up, by the aid of the arc, to their original size, the whole job being completed within twenty-four hours. A similar difficulty occurred with a cast-steel helical wheel weighing over six tons, belonging to a reversing plate mill. The steel was too soft; so the wobbler ends were worn, while the teeth were still perfect. The spare wheel was put in place, and the ends of the shaft, which had been removed, were rapidly restored to their original size. In like manner, bearings that have been worn down a dangerous amount can be built up and re-turned, restoring the shaft not only to its original form, but also to its former strength. In one instance some shafts for driving live rollers were made two and one-half inches too short, and the extra length of shaft was electrically welded on by building up. As an example of a larger job, cast-iron cogging mill live rollers, which broke at a point where they were 10⅝ in. diameter, were electrically welded satisfactorily. The teeth of cast-steel wheels which have been broken while working have also been repaired without removing the wheels from their shafts.

"For rapid boiler repairs, the work is most efficient. It enables a patch to be applied in difficult places, where riveting would be impossible without partly taking the boiler to pieces. For instance, in a boiler wasted by corrosion at a point on the outer shell, when the defect was cut away, there was a hole 5½." A piece of mild steel plate was fitted over the hole so as to lap 1½" all around. It was satisfactorily welded on by applying the electric arc to the junction of the plate and shell. The whole job, including testing by hydraulic pressure, was completed in ten hours. To have at hand a means of mending broken parts without removing them from their places must be of great advantage, especially in a rolling mill where breakdowns are frequent and costly.

"The minimum requirements for the kind of electric welding in use at Spencer & Co.'s are three hundred amperes at a pressure of eighty volts, while five hundred amperes are preferable. This means fifty-four electrical, or seventy indicated h. p. This may be obtained from an engine and dynamo of that size, or from a plant half the size, aided by a battery of accumulators. Thirty to thirty-five per cent. of the energy needs to be wasted in resistance, in order that the total resistance in the circuit may not be greatly varied, as the workmen shorten or lengthen the arc in the manipulation of the job.

"When there is no electrical apparatus on the premises, it becomes a very serious matter to fit up a plant for a few jobs, but when there is apparatus and work to be done of the above class, it will be a great saving.

"The precautions to be observed are not many. The metal to be welded, if iron or steel, should be the positive pole, but, if of other metal, such as lead, it should be the negative pole. The volts should be sixty-five and ninety-five at the machine, and should be reduced thirty to thirty-five per cent. in the passage of the current to the weld. In 'building up,' the metal introduced into the weld should be as nearly as possible of the same composition as the article to which it is welded, and the workman should remove the slag formed on the surface of each layer added, before commencing to add another. In cases where the part to be 'built up' projects above the surrounding surface,—for instance, a

tooth,—each layer of material added should be retained in position, and prevented from flowing away by forming a ridge of finely-ground ganister clay around the circumference of the layer to be added. Many firms have tried this process, but it has found its best outlet for mending castings and for doing repair work of the sort above mentioned."

The methods of Coffin (American) and Hoho and Legrange (Belgian), and the Zerener method recently reviewed in this department, are also discussed. Not much is added to previous knowledge, but the subject is presented in a popular and agreeable style.

The Willans Engine.

PROFESSOR JOHN E. SWEET, writing in *Machinery* for February of special features seen by him in British work-shops, closes a very interesting contribution with the following description. "At the engine-works of Willans & Robinson, Thames Ditton, two wonders await every American, except those who will not admit that anything can be done except what we do. There are a number of features about the engine that students in engineering have been taught to believe are contrary to the best practice, but experience shows that they produce the results, and the style of the engine renders good work necessary, and the good work produces the results where it would be wasted on other designs.

"The cylinders and steam chests are piled up one above another, and it is important that they be true and in line. These cylinders are bored, reamed, and faced on an ordinary lathe, a regular English lathe, with no features except a holder attached to the slide rest to carry the reamer,—that is, the reamer is held and driven through the work by the slide rest, and not by the tail stock. Mr. Eaton Shore (the works manager, who, as well as every one connected with the company, gave me every attention, all information, and every opportunity possible to see and learn) is firmly of the opinion, as I am now convinced, that the results obtained could not be continuously produced by the tail stock feed. As an example, a half-dozen cylinders some 14 in. diameter and a foot or so deep, with a flange outside at one end and inside at the other, were by the lathe, just finished. One taken at random was sent to the testing floor and placed on an oiled surface plate. The testing plug, made like a web pulley with about 2½ inches face, was started in the cylinder and crowded down until about even at the top, when, with a finger on the top at one side, the plug was shown to be so free from contact with the sides of the cylinder as to spin around like a top. The man then stood upon the plug, and it carried his weight on the air. This job probably could be done in any good shop, if one went at it the right way, but for one thing; the castings are made of re-cast pigs, re-cast after the mixtures are made. This makes a uniform iron, which is more likely to keep its shape, but it is very hard, and that makes the work difficult. Such hard cylinders and the accuracy contributes to the success of the engine, but such accuracy would be of no particular advantage in an ordinary engine, when the cylinders are distorted by steam in one place or on one side and exhaust in another.

"The Willans is, in its design, workmanship, and method of construction, so dependent one upon the other that it is not easy to describe how things are done, and give them their due force, without describing the engine itself; and the whole would be more than a single article would cover. . . . They have in use what I understand is a common thing,—a flexible copper steam pipe, capable of resisting any required pressure, that bends around like a rubber hose. Not a double wire arrangement like Almond's, depending on mechanical fits, but an absolutely tight copper-pipe, constructed in such shape as to be easily bent around; an ideal device for an erecting floor.

"It is useless to attempt a description of the interesting and wonderful things to be seen at the works of the Willans & Robinson Co., and to one who appreciates wonders some such thought as this must come to him,—the death of a great engineer is a loss to the world. When Peter William Willans died, the world lost a genius."

Professor Sweet always writes interestingly, and is altogether one of the most keen-eyed observers of mechanical progress this country possesses. It is to be regretted that his contributions to mechanical literature are not more frequent.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

3813. On Wastes and Shop Handling. John Richards (Extracts from recent lectures before the students of Leland Stanford Junior University, Palo Alto, Cal. Percentage that should be added for waste, in estimating cost of machinery, methods of arriving at weights, through dimensional data, and suggestions to designers directed to avoidance of excessive waste of material in construction). Ir Tr Rev-Jan. 23. 1600 w.

3870. The Forge Shop at the University of Nebraska. C. R. Richards (Illustrated detailed description). Am. Mach-Jan. 30. 600 w.

3873. The Comparative Efficiency of Belts and Ropes. M. E. (A critical review of the experiments carried out by the Société Industrielle du Nord de la France, at Lille). Am Mach-Jan. 30. 1400 w.

3875. Some Special Features Seen in British Work Shops. John E. Sweet (A very interesting account given by a keen observer and closing with a warm tribute to the genius of Peter William Willans, whose death was a loss to the entire world). Mach-Feb. 2500 w.

3876. Pattern Shop Supplies. John M. Richardson (Judging from the first part, this is to be a series of practical hints and suggestions, relating to supplies and appliances for pattern shop use with information gained from experience as well as from other sources). Mach-Feb. Serial. 1st part. 1600 w.

3877. Observations in an Old Shop. Ill. (Shop of the Silver and Gay Co., North Chelmsford, Mass. One of the pioneer shops of this country, established in 1832. Differences between tools of sixty years ago and those of present date are noted). Mach-Feb. 1100 w.

3878. Practical Notes on Steel. (S. W. Goodyear (The position is taken that, in general, steel will behave well if applied to the purposes for which it is best adapted, and that, therefore, it does not deserve the reputation of being refractory and unmanageable, in which it is held by mechanics. The article is directed to the guidance of mechanics in the selection of steel adapted to special purposes, and the judicious selection of adaptations for special qualities of steel). Mach-Feb. 2300 w.

3879. Aluminum Alloy to Replace Brass (An alloy which if it proves to possess the qualities claimed must prove of value in machine construction). Mach-Feb. 600 w.

3880. Blow-Out Pipes on Boilers. W. A. Carlile (Practical treatment of the subject). Mach-Feb. 1300 w.

*3896. The Helve Hammer in a Railroad Shop. O. H. R. (An excellent practical article in which the dies for a great variety of work done with this class of hammers are described and illustrated. This article will lead to a higher impression of the value of one of the oldest types of machine hammers which still retains a field of usefulness notwithstanding it has been thrown into the back ground by modern improvements). Loc Engng-Feb. 1300 w.

*3899. Sketching. O. H. R. (A first class practical paper full of useful hints and presented in concise and clear style. The usefulness of the accomplishment of being able to make readily a good free hand sketch is exemplified, and by following the directions given, there are few who could not acquire it). Loc Engng-Feb. 2400 w.

*3944. Casting Pump Pipes. Ill. (Describes Scotch practice which differs in some respects from English practice). Eng, Lond-Jan. 24. 1600 w.

*3948. Accuracy (Editorial dealing with the degree of accuracy most desirable in mechanical construction, viewed both from the standpoint of the purchaser and the manufacturer). Eng, Lond-Jan. 24. 2200 w.

4062. Belt Experiments (A general review of results obtained by various experimenters, including experiments of Morin, Briggs and Towne, Leloutre, Lewis, Lanza, Fauquier, and the recent experiments at Lille). Bos Jour of Com-Feb. 8. 2000 w.

Steam Engineering.

3569. Steam Consumption of an Engine.—How It May Be Measured. Thomas Hawley (Extract of lecture delivered in Lowell Free Course, at Wells Memorial Institute, Boston. Discusses methods of interpreting indicator cards, and the use of data so obtained in computation). Bos Jour of Com-Jan. 11. 2000 w.

3574. Some Things Engineers Should Know (A series of questions and answers relating to practical management of engines and boilers). Lord's Mag-Jan. Serial. 1st part. 4000 w.

*3590. On Entropy and Entropy Diagrams. Prof. Boulvin (The graphic method in the study of thermodynamics is shown in this paper to be of the highest value. An experimental application of the entropy method to a compound condensing engine is described, with results and conclusions). Engng-Jan. 3. 5000 w.

3700. Heating from Intermediate Receivers (An attempt to show wherein heating by this method results in gain, and to determine the gain quantitatively). Eng Rec-Jan. 18. 900 w.

*3709. Circulation in Water-Tube Boilers (Illustrated detailed description of a remarkable series of experiments carried out at Messrs. Yarrow and Co.'s Works (England), with editorial introductory remarks. The apparatus used

We supply copies of these articles. See introductory.

and illustrated is elaborate and costly, and the experiments throw much light upon this much debated question). Eng, Lond–Jan 10. 4800 w.

*3710. Megass and Refuse Furnaces. William Price Abell (Illustrated detailed description of furnace for utilizing refuse as fuel, and a general and practical discussion of the subject). Eng, Lond–Jan. 10. 2200 w.

*3717. The Wheels and Why They Burst. Charles Henry Benjamin (Read before the Elec. Club of Cleveland. Includes also a description of a steel built up fly-wheel). St Ry Rev–Jan. 15. 2800 w.

†3804. Measurement of Temperatures of Steam. D. S. Jacobus (This paper presents experiments made to determine how nearly thermometers, placed in mercury or oil wells inserted in pipes, register the temperature of steam passing through the pipes. Apparatus illustrated and method explained with some of the conclusions derived). Stevens In–Jan. 6500 w.

*3818. The Combustion of Powdered Coal (Illustrated description of the Wagener apparatus, with table of data of an experimental trial, conducted by Mr. Bryan Donkin and Prof. Kennedy of a Cornish boiler, fired according to this system. No fan is required for the operation. The fuel is fed to the furnace by a sieve and an ordinary chimney supplies the necessary draft). Engng–Jan. 17. 700 w.

*3821. Water-Tube Boilers (Correspondence —Critical discussion of recent experiments, by engineer G. Gretchin, of the Russian Volunteer Fleet, Charles Bellens, of Paris, F. Strickland, and John Thorn, M. I. N. A. Interesting points are brought out in this running debate). Engng–Jan. 17. 2200 w.

*3823. Receiver and Condenser Drop. A. C. Elliott (The belief that "drop" dries steam is declared to be an ancient superstition. Deals with the subject mathematically and thermodynamically). Engng–Jan. 17. 1600 w.

*3833. The Efficiency of Motors (Editorial review of the technical meaning attached to the word "efficiency" as now applied in records of steam engine trials). Prac Eng–Jan. 17. 700 w.

3871. The Value of the Steam Jacket. Charles T. Porter (Heat does the work. The elastic steam is only a medium. The thermal changes and exchanges in steam cylinders are traced, and it is shown that the jacket is an economical appliance). Am Mach–Jan. 30. 1500 w.

3872. Increasing the Heating Surface of Boilers. F. F. Hemenway (A criticism of a tendency, which is chiefly manifested by those who assume to design boilers, with insufficient knowledge of principles. It does not follow that the larger heating surface belongs to the most efficient boiler). Am Mach–Jan. 30. 1100 w.

*3897. New York, Ontario & Western Passenger Locomotive (Illustrated brief description with table of dimensions). Loc Engng–Feb. 800 w.

*3898. Ten-Wheel Pittsburgh Compound for the Vandalia (Illustrated brief description). Loc Engng–Feb. 400 w.

*3939. The Solignac Mixed Boiler (Interesting illustrated detailed description). Am Eng & R R Jour–Feb. 2400 w.

*3955. Trial of Compound Engines. Michael Longridge (Trial of a pair of beam engines with steam-jacketed cylinders working compound. Extensive list of data obtained, followed by comments upon indicator diagrams and conclusions). Engng–Jan. 24. 3500 w.

*3956. On the Surface Condensing Plant at the Newcastle and District Company's Electric Lights Works, Forth Banks, Newcastle, on the Tyne. William Cross (Paper read before the North-East Coast Inst. of Engs and Shipbuilders. Illustrated detailed description). Ind & Ir–Jan. 24. 2000 w.

3976. On the Support of Long Cylindrical Boilers (Practical treatment of proper and improper methods with diagrams). Age of St–Feb. 1. 1000 w.

3977. Sectional Water Tube vs. Shell Boilers. L. G. Read (The pros and cons of this subject are summed up in this paper). Age of St. Feb. 1. 2400 w.

3988 Water Gauge Glass Failures. P. M. E. (Causes of breakage, and their relation to the higher pressures now carried, with practical hints). Power–Feb. 1600 w.

3990. Experimental Determination of the Efficiency of Steam Boilers with Varying Rates of Fuel Combustion. F. G. Gasche (Methods whereby the subject of boiler efficiency can be satisfactorily studied. Formulæ constituting a rational basis for such study). Power–Feb. 1800 w.

3991. Cause of Fly-Wheels Bursting. W. K. Austin (Lessons from experience and observation. Jarring is considered a potent factor in the destruction of fly-wheels). Power–Feb. 900 w.

4013. Spray Nozzles for Cooling Water of Condensation. Ill. (Method of using water for condensing steam over and over again in places where water supply is limited). Am Mach–Feb. 6. 200 w.

*4079. Can the Cost of Power be Reduced? F. Riddell (The answer to the question is affirmative for many mills now operating, and hints at methods for stopping small leaks are given). Am Miller–Feb. 1700 w.

Miscellany.

*3585. Factories and Workshops). A bill that came into operation in England, on Jan. 1, 1896, is somewhat criticised and its benefits noted). Arch, Lond–Jan. 3. 2000 w.

*3592. The Le Blaut Steam Road Carriage (Illustrated detailed description). Engng–Jan. 3. 4400 w.

*3624. American Self-Propelled Carriages (A very thorough review of the state of the art in America, with illustrations and general description of the principal carriages of this class that have been brought out in the United States). Eng, Lond–Jan. 3. 4400 w.

3630. Compressed Air Mechanisms. Charles Henry-Cochrane in "The Wonders of Modern Mechanism" (A review of the use of compressed

air as a motive power and for various mechanical purposes'. Progress of the World–Jan. 1000 w.

3643. The Vicissitudes of a New Industry (A most instructive article given in the form of a letter from a friend solicited by an inventor to take stock in a company formed to manufacture a new and valuable patented improvement. It might profitably be read by many now contemplating the best way to commercially exploit new improvements). Ir Age–Jan. 16. 3000 w.

3660. The Gates Iron Works Drawing Room. John Randol (Illustrated detailed description, with plan of room, etc). Am Mach–Jan. 16. 2200 w.

3671. The Water of the Drainage and Ship Canal, and Its Transmission to Chicago. H. S. Putnam (A paper read at a meeting of the Illinois Chapter of the American Institute of Architects, claiming that both from an engineering standpoint and financially one can scarcely overestimate the importance of this canal as a source of power for the city of Chicago). Elec Eng–Jan. 15. 2200 w.

*3707. The Jenny Lind (History of a locomotive of great interest as being in a large measure the forerunner of the standard type of English locomotives. The first part describes the incidents connected with its building and competitive trial, and promises illustrations of details in a future number). Eng, Lond–Jan. 10. Serial. 1st part. 1200 w.

*3708. The Theory of the Lubrication of Plain Parallel Surfaces. R. M. Deeley and C. E. Wolff (An important paper reprinted from the Transactions of the Royal Society, with nine tables of constants). Eng, Lond–Jan. 10. 3000 w.

*3749. An Autographic Testing-Machine Attachment. Thomas Gray (Description of a device whereby automatic and autographic records of the relation between the force applied and change of dimensions are obtained). Digest of Phys Tests–Jan. 2700 w.

3796. Notes on the Invention and Development of the Slide Rest. W. F. Durfee (Historical in character and of much interest). Am Mach–Jan. 23. 2800 w.

3797. A Turbine of the Niagara Power Co. Ill. De Volsen Wood (Results of calculations of the performance of a large turbine of the Fourneyron type, based upon data supplied by Prof. Coleman Sellers). Am Mach–Jan. 23. 1500 w.

†3801. A Curious Mechanical Movement. C. W. Mac Cord (Describes and illustrates an ingenious piece of mechanism for turning on and shutting off gas at a distance and which is possibly applicable to other purposes). Stevens In–Jan. 1400 w.

*3814. The Design and Testing of Centrifugal Fans (Abstract of a paper read by Messrs. H. Heenan and W. Gilbert, disciples of a method and apparatus for determining best form of fan blade and fan case, and most economical speed and diameter of fan to move any desired volume of air under any given pressure). Mach, Lond–Jan. 15. 900 w.

*3822. Experiments on Wind Pressure. H. C. Vogt (General discussion stating the writers' relation to the experimental researches of Prof. Irminger, and giving a formula for computing efficiency of wind propellers). Engng–Jan. 17. 2400 w.

*3824. The Strength of Cylindrical Shells. F. Keelhoff (Very abstruse mathematical discussion. The conclusion is reached that it is useless to take any account of the action of the ends in modifying the stresses in the shell of an ordinary boiler, and that the effect of the ends is as likely to increase as to diminish these stresses). Engng–Jan. 17. 1800 w.

†3842. A Coming Revolution in Power. F. Jarvis Patten (The writer looks for a "gas age" and prophesies a wonderful revolution due largely to the perfection of the gas engine). New Sci Rev– Jan. 2000 w.

3852. The New York Trade Schools. Ill. Owen B. Maginnis (An article in praise of these schools, and an account of a recent visit to them). Arch & Build–Jan. 25. 1300 w.

3912. Progress Toward the Age of the Horseless Carriage. T. A. De Weese (Illustrated historical sketch of progress in this field). Cos–Feb. 3400 w.

*3949. On Measurements of Small Strains in the Testing of Materials and Structures. J. A. Ewing (An important and exhaustive illustrated paper, with description of numerous experiments, and tabulated results. The experiments were made with a new kind of extensometer, which is described in detail). Eng, Lond–Jan. 24. 3500 w.

*3963. The Berrenberg Mechanical Pump (An illustrated description of a pump for the exhaustion of an electric incandescent lamp). Elec Rev, Lond–Jan. 24. 1600 w.

3989. Friction of Bearings. J. H. Holmes (A learned discussion of the friction of bearings other than plain, parallel, sliding contact bearings. The subject is ably treated). Power–Feb. 1800 w.

4010. Water Motors and Their Power. G. D. Hiscox (Deals with the class of motors now upon the market for supplying small power. Details of their construction are illustrated). Sci Am Sup–Feb. 8. 1800 w.

4012. The Measure of the Instantaneous.—The Time Occupied in Oil Engine Explosions. Tecumseh Swift (An important question ably discussed). Am Mach–Feb. 6. 700 w.

†4058. Are Patents Worth Anything? C. D. Frost (A reply in part to an article in *Electrical Engineering* (Chicago) and giving the writer's views on the valuelessness of letters patent). Ind Rub Wld–Feb. 10. 1400 w.

*4077. The English Steam Whizzer (Illustrated description of a new device for washing wheat previous to grinding it. The process is so rapid and thorough that in passing through the whizzer, while the wheat is nicely cleaned, the grains do not absorb moisture enough to interfere with grinding, and moisture adhering to the surface is separated and thrown out by centrifugal force). Am Miller–Feb. 500 w.

We supply copies of these articles. See introductory.

MINING & METALLURGY

Treatment of Low-Grade Ore.

GOLD and silver mining is one of the most profitable of undertakings when carried on in a business-like way. Most of the failures are due to ill considered action by the promoters in organizing the company, or the directors in its management; and the most serious blunder made by the latter is the adoption of a process for treating the ore which has not been sufficiently tested before installing the plant. An experienced engineer's judgment will go far in selecting the best method of extraction, but this method should be subjected to preliminary tests before the plant is bought. Mr. Edmund B. Kirby treats of this subject in a valuable article in *The Mining and Scientific Press* (Jan. 18) as follows:

"It is well understood that of the two general divisions, 'sulphid' and 'oxidized ores,' the former includes all those forms in which gold was originally deposited in veins. Within reach of the aerated surface waters the sulphid minerals are found more or less decomposed, with their gold contents set free. Nature has here done slowly the very work which would otherwise have to be performed in roasting furnaces."

With completely oxidized ores a high-speed California stamp mill should be used, which will treat ore from 35 cents to $1.00 per ton. Where the gold is free, but very finely divided, amalgamation must follow stamping. The Gilpin county (Col.) type stamp mill is of slow speed and designed for ores little or not at all oxidized. It will save sixty to seventy per cent. of the gold in the battery and on the plates. Telluride minerals will not yield to amalgamation or concentration, and must be treated by the chlorination or cyanid process. Combination milling means amalgamation followed by concentration.

"Two general types of combination plants are in use. In one the ore is crushed by stamps to the usual sand size, and then treated on vanners or other simple concentrating machines. The sands, now free from sulphids, are then ground fine and amalgamated in pans.

"In the second type the ore is crushed by rolls to about bean size. It is then treated in a complete concentrating plant of screens, jigs, hydraulic sizers, buddles, vanners, etc., more or less elaborate, according to the requirements of the case. The tailings from the concentrating department are then recrushed to sand size and amalgamated on plates or in pans. Combination plants of fifty tons' daily capacity cost from $30,000 to $60,000, and the expense per ton is also greater; but a much larger extraction is secured.

"When the problem cannot be solved by any of the above methods, it is necessary to resort to barrel chlorination or the cyanid process. In barrel chlorination all the sulphids must first be removed by roasting, before chlorine can act effectively upon the ore. This is more difficult and expensive than ordinary roasting, where a complete removal is not necessary. Another objection to the chlorination is that no silver is saved, and, since most gold ores also contain silver, the loss from this cause may be serious.

"The cyanid process requires no roasting, since the solutions penetrate the cleavage planes of the sulphid crystals and dissolve a large percentage of both gold and silver. Neither process will recover the gold present in coarse flakes and grains. Both require very expensive and carefully designed plants, which may cost $50 000 to $75,000 for fifty tons' daily capacity. Chlorination extracts ninety to ninety-four per cent. of the gold only, while the cyanid process recovers seventy-five to eighty per cent. of both gold and silver. The latter is, therefore, specially adapted to the lower grades of ores, and its expense is about two-thirds that of chlorination. Each process has its own

field of application, and the question as to which is best for a given case is not easy to decide. At present the cyanid process is being applied to ores in three different ways:

"First—As an adjunct to the process of ordinary wet stamp milling. The tailings from the stamp mill are further treated in a cyanid department. This is the method in universal use throughout the South African fields. At first the old dumps of accumulated tailings were worked up, and then the cyanid plants were modified to take fresh tailings continuously from the stamp mills. The system has the following advantages: It is the cheapest of the three in cost of plant and expense per ton. All large grains of gold which would escape from cyanid solutions are saved by the amalgamation. Moreover, since many of the mills use concentrating machines, the sulphids are separated in a small bulk, and this is treated with more care and expense than would be profitable upon the ore itself. The disadvantage of the system is that the crushed material flowing as tailings from a wet stamp mill contains such a large proportion of flour-size particles or slimes that the cyanid solutions will not percolate through it. It is, therefore, necessary to separate the sands from the slimes, and treat only the former. The slimes, amounting to thirty per cent. of the total weight, have to be thrown away. The Johannesburg ores average $12 in gold, and the stamp mill amalgamation takes out about sixty per cent. of this, or $7, leaving $5 per ton in the tailings. Thirty per cent. of these tailings are thrown away as slimes, and the remaining sands are subject to cyanid treatment. This extracts seventy per cent. of the gold in the sands, making the total recovery $9.50, or about eighty per cent. of the gold originally present in the ore. The remaining $2.50 is lost. If it were only possible to treat these slimes effectively by cyanid, this system would be the one best suited to most mines in the United States. A cyanid plant could then be attached with ease to any western stamp mill, and the saving greatly improved. Up to the present such attempts in this country have been failures. Various plans have been proposed to overcome the difficulty, and it is probable that a working plant could now be built to treat slimes.

"Second—The ore is crushed in an ordinary dry crushing stamp mill. It is placed dry in vats, and the cyanid solutions allowed to percolate through the mass. This system has been tried in New Zealand, Australia, and various parts of this country. Its results have, on the whole, been rather unsatisfactory. The trouble is that dry stamp crushing produces so much fine powder that percolation is very difficult and slow.

"Third—The ore is crushed dry in a more complicated and expensive plant of rolls and screens. The object of this is to avoid the production of slimes, and thus to do away with all the difficulties of percolation. It is a very delicate undertaking to accomplish this without at the same time having the grains of ore so coarse that the solutions cannot reach their gold contents. The large number of failures which have occurred in the attempts to apply cyanid by this system have made it clear that, in order to ensure success, it is necessary to have a very expensive plant, designed by the best metallurgical skill."

Feeder for Powdered Fuel.

THE Wegener automatic system of burning powdered coal was devised in 1892. It was closely followed by the Friedeburg and Schwartzkopf systems, and has been in use at the Bermondsey works, England, for some time, where it gave an economy of as high as twenty per cent. over hand-stoking. The automatic stoker used in the Wegener system is thus described in *The Colliery Guardian* (Jan. 24):

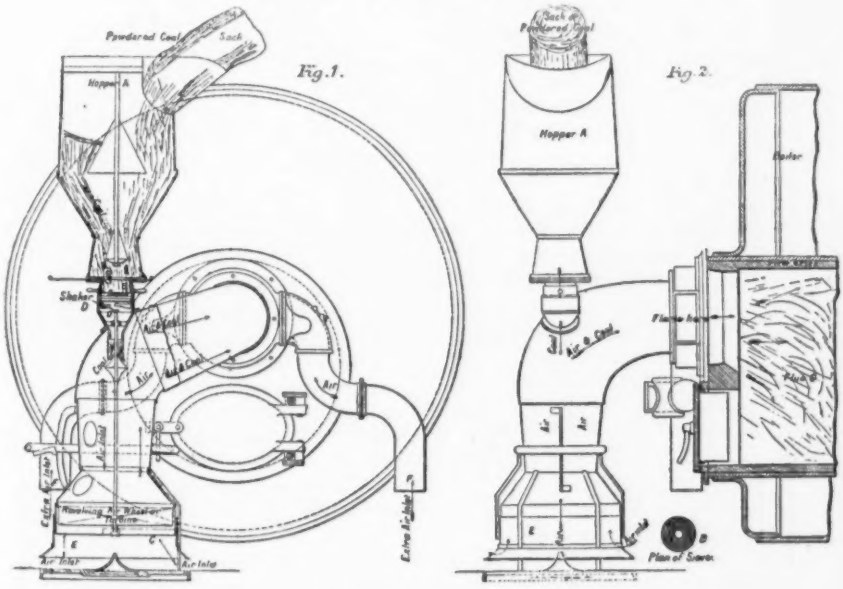
"The Wegener apparatus has been much simplified, and now it would seem difficult to find a more elementary and yet efficient construction. The coal-dust is contained in an overhead conical hopper, at the bottom of which is a sieve, about 5½ in. in diameter. This sieve is tapped automatically so as to cause the coal to fall through into a vertical pipe, where it meets an upward current of air produced by the

chimney draught. The mixed air and dust then pass directly into the boiler furnace by means of a quarter-circle bend on the vertical pipe. In order to shake the sieve, a fan in the air-pipe is driven by the natural draught, just like an old-fashioned smoke-jack, and, in turn, drives a small hammer, which taps the sieve about 150 to 250 times a minute. The strength of the blow is controlled by a spring and stops, both of which are adjusted by small hand-screws, so as to regulate the amount of coal used. The air supply is regulated by raising or lowering the lower end of the vertical pipe, which nearly reaches the floor. As the fan is placed nearly at the bottom of this pipe, some five feet below the sieve in the hopper, the falling dust does not reach it, and the moving parts generally are of very light and simple construction, so that the cost of repairs necessary will be light. In fact, an ordinary tinsmith could construct nearly the whole of the apparatus. The main air-supply pipe is some twelve or more inches in diameter, but additional air can be supplied by extra pipes closed by dampers. These are only used with very bituminous coal.

"The cost of pulverizing to pass through a 60-mesh screen, starting with slack coal, is given at about ten per cent., or not more than one shilling a ton. Any disintegrator, or other type of machine suitable for the purpose, is used. This item of cost has to be set off against the saving of labor in stoking and the cheapness of the fuel that can be used."

Though this apparatus is so highly spoken of, there are several points in construction which will strike an engineer at once as being inefficient.

THE WEGENER POWDERED FUEL FURNACE.



The Russell Process.

THIS method of silver extraction, having passed through the usual experimental stages, has reached a point in economical working where it attracts the attention of mill-owners generally. Tailings which would otherwise be thrown away are treated efficiently by these hyposulphite solutions, the silver recovered being an important item contributing toward a

company's dividends. Mr. Carl A. Stetefeldt briefly describes the process* invented by Mr. E. H. Russell as follows:

"Russell discovered that a solution of a double salt of sodium and cuprous hyposulphite, formed by mixing sodium hyposulphite with copper sulphate, exerts a most energetic dissolving and decomposing action upon metallic silver, silver sulphid, silver minerals belonging to the group of antimonial and arsenical sulphids, and other silver-combinations. Hence, if a charge of ore is first lixiviated with ordinary sodium hyposulphite solution, and, subsequently, with a solution containing a double salt of sodium and cuprous hyposulphite,—this solvent is called the extra-solution,—an additional amount of silver is extracted, which would have been lost in the tailings by working according to the old method alone."

Results obtained on thirty thousand tons of tailings, treated by this process at the Yedras Mill, Sinaloa, Mexico, show a product averaging seven thousand ounces of silver per ton and the following extraction:

Year.	Value of Ore. Ounces per ton.	Per cent. Extraction in Assay Office. Russell Process.	Per cent. Apparent Extraction in Mill. Russell Process.	Per cent. Actual Extraction in Mill. Russell Process.
1888	19.49	62.70	60 14	62.74
1889	17 23	57 20	55 95	60.14
1890	13.46	49 26	48 37	46.84
Av'g's.	16 73	56.39	54 82	56 57

"Russell also discovered that lead can be completely separated from a sodium hyposulphite solution, as lead carbonate, by sodium carbonate. After decanting the solution from the lead carbonate, silver and copper are precipitated from it in the usual way. This method of separating lead prohibits the use of calcium polysulphid as a precipitant for silver, because calcium entering the regenerated lixiviation-solution would also be precipitated as a carbonate with the lead by sodium carbonate. Hence, sodium sulphid must be employed. A full investigation has demonstrated that this is by no means detrimental. Sodium sulphid and hyposulphite are more advantageously used in the lixiviation-process than the corresponding calcium-salts."

*"The Lixiviation of Silver-Ores with Hyposulphite Solutions." Carl A. Stetefeldt, author and publisher, 967 Alice St., Oakland, California. Second edition, 204 pp. Cl. Price $5.00.

Fusibility of Sand for Furnace Bottoms.

THE qualities which go to make a firm refractory floor or bottom for furnaces used in heating steeel ingots or blooms previous to passing them through the rolls are well enumerated by Mr. Charles Ferry in *The Iron Age* (Dec. 19). He says:

"The grades of sand to which I have particular reference are those used for making bottoms of reheating furnaces in rolling mills. The characteristic feature of a good bottom sand is its ability to 'set,' forming a hard, durable furnace bottom. But sands which contain clay or are of a 'loamy' nature cannot be used with any degree of safety. The tendency of such sand is to stick to the hot iron; then, when a bar is rolled, a lump of the bottom sand is liable to be found imbedded in the finished product. While it is essential that bottom sand should set quickly after having been thrown into the furnace, it must not be of such a fusible nature as to become seriously affected by the heat of the furnace. If siliceous material, like sand, is partially fused, or even approaches that state, it assumes the same sticky property which clay gives it, and that causes trouble."

It was supposed by some that the percentage contents of silica determined the refractory nature of a clay. "This view is not supported by experiments, as is shown by the following analysis. Permit me to tabulate the analyses of two specimens of bottom sand.

	A, good Per cent.	B, poor (fire sand) Per cent.
Silica, total, SiO_2	91.55	91.47
Alumina, Al_2O_3 / Ferric oxid, Fe_2O_3	7.40	4.88
Lime, CaO	0 51	0 21
Magnesia, MgO	0.11	none
Water of combination	0.61	3.61
Totals	100.18	100.17

Coarser-grained sands require a higher temperature to make them "set," though the chemical composition may be identical.

"For the furnace in which several practical tests were made the sample A seemed to give excellent results, while sample B, which carried about the same quantity of (total) silica, did not 'set' hard. A bottom was made in the reheating furnace with sand B, but, even after waiting fifteen to twenty minutes, the sand would show no tendency to bind together.

"After such widely different results were obtained from two samples of bottom sand which apparently contained about the same percentage of silica, I came to the conclusion that the quantity of silica present was not the only characteristic of sand to be considered in determining a specimen suitable for this work.

"If chemical analysis is to be the only guide to choosing bottom sand, I think the results should be interpreted in a similar manner to that of fire clay. Before passing judgment upon a specimen of 'refractory clay' from its chemical composition, it is necessary to arrange the results obtained from analytical work in the following manner:

Silica (combined) Alumina, Quartz,	Refractory constituents.
Water (combined),	Plastic properties.
Lime, Magnesia, Ferric Oxid, Fixed Alkalies,	Fluxes.

"Besides these chemical features of a bottom sand, there is an important physical condition which must not be forgotten,—*viz.*, the size of grain or degree of coarsenesss.

"As the more plastic clays—*i.e.*, those containing the larger percentage of kaolin or hydrated silicate of alumina—render the silica sands less refractory, it follows that, the more water the kaolin contains, the more fine-grained and plastic it will be, and the more it will impair the refractory nature of the sand. A clean sharp sand without water would also be without clay.

"The fluxes—lime, magnesia, iron, and the fixed alkalies—are the substances which play the most important part in the 'setting' of bottom sand. In the aggregate these constituents probably amount to four or five per cent. in many samples of bottom sand. The fluxing powers of these substances with silica are nearly all different; therefore, to bring about the same results the sand would require the presence of possibly twice as much of one as another. In other words, if the fixed alkalies were the fluxing base in one case and ferric oxid in another, of two samples of bottom sand which work practically alike, we would find the percentage of the latter would far exceed that of the former. It is possible that alumina assists the fluxes in the work of 'setting' bottom sand, but not enough to warrant our giving it credit for a decided basic nature. Then, too, we find it refractory and slow to combine with the fluxing impurities of the bottom sand. For this reason it is reasonable to believe that the effect of alumina in bottom sands is the same as in fire clay, for, when either is subjected to high degrees of heat, this constituent does not act like a base, combining with the silica to form fusible compounds."

The author thinks that it is better to develop an accurate system of chemical tests than to risk losses of steel or bottoms by practical tests with new sands.

The Coolgardie Gold Fields.

A CORRESPONDENT of *Indian Engineering* (Dec. 21) writes from Coolgardie as follows: "Coolgardie is a rudimentary mining town of shanties mostly, at the extreme southwest corner of a vast strip of auriferous territory—roughly, two hundred miles wide—which stretches obliquely across Western Australia into the utmost north of the territory known on the maps as the Kimberly district. The town of Coolgardie lies about four hundred miles due east of the port of Fremantle, which is close to Perth." A railroad establishes communication to Southern Cross, two hundred and forty-eight miles inland, the remaining distance being still in the hands of the contractor. The country is

a dry sandy waste, "covered with a species of eucalyptus, the foliage of which spreads out at the top into a graceful fan that becomes very monotonous, while the absence of landmarks renders the traveler very liable to lose himself and die from thirst. Water is secured by cement-lined channels leading to catch basins, which are made rectangular in section in order to minimize evaporation, and are locally known as "Sooks." A temperature of 110 deg. is common, and the white laborers work through the eight hours in the usual way, taking no advantage of cool mornings.

The latest water-supply scheme proposed is to distil the water obtained from wells in dried-up lake bottoms. This water is salty, and it will cost £75 per week to distil 40,000 gallons daily. It will be conducted twelve miles into a reservoir above the town, and earn a water rate of two pence per gallon, as against four pence, the present rate. Galvanized pipes are unpopular, as the zinc dissolved is thought to aggravate any inclination to suffer from fever.

Kerosene oil engines are used, owing to the scarcity of water and the improbability of ever pumping water four hundred miles from the ocean. They are used to drive stamp mills. The Akroyd and Priestman types are employed principally, and their use will probably soon extend to tramway haulage. The district itself is in an embryo state, struggling hard to get out of the shell with the aid of British capital. Although gold is being produced, it is the speculator who is doing the most effective work.

"The routine of gold-mining operations at Coolgardie is familiar to anyone who recollects Wynaad in the years 1880-81; only it is being repeated on a much larger scale. Briefly, a class of mineral viewers exists in Australia who are generally fitted out with camp equipment, and have their expenses paid by syndicates at Melbourne, Adelaide, and Sydney, who raise a capital of about one thousand pounds at a time. These viewers examine the wilds, and, on finding payable quartz, peg out a claim of say forty acres for each member of a search party, which is surveyed and registered as the property of the syndicate, under the mining act of the colony. The syndicate have then to keep a man on nominal work upon each claim as long as they wish to retain a title. Just now wages amount to £4 per man weekly, and, with any other work incidental, there is a heavy unproductive outlay, till machinery which may cost £10,000 is erected by a powerful company. The next process is to enlarge the syndicate into a regular mining corporation, and dispose of the whole property on the reports of mining experts to a new company with directors in London, and whose shares are quoted on the stock exchanges. In the case of Wynaad, it may be remembered, those companies were formed right and left, and shares rose and fell long before a stock of machinery had time to reach the ports of India, still less get transported up the Western Ghats, and crush any gold.

"There are computed to be 20,000 people on the Coolgardie Goldfields; wages are £4 a week per man, and the lowest cost of ordinary living about £2-10-0 a week, while the monthly outturn of gold is only 14,000 ounces, worth £53,000, from all the few mines now working combined, or a quarter of the bare subsistence of the population. The problem is from what source—be it London or the savings of Sydney, Melbourne, and Adelaide—the rest of the brisk expenditure undoubtedly going on is derived."

Etching Tests for Iron and Steel.

THE following observations are described in *The American Manufacturer* (Feb. 7) as being originated by Professor Kick, of Prague. The metal is first highly polished, then immersed in 1.062 specific gravity muriatic acid until the etching is plainly visible, washed in water, brushed, and finally washed in dilute spirits of sal-ammoniac; after drying, rusting is prevented by means of a thin coat of clear gum-lac. The characteristic tests are:

"*Soft or fibrous forge iron.* If it is of excellent quality, it will be attacked uniformly, even if the action of the acid has lasted for several hours; defective places

and ash holes make their appearance. The cauterized surface appears bright and of weak lustre. '*Fine grain' iron.* The conduct is similar to that above. The cauterized surface appears still more uniform, but darker.

"*Coarse grain or cold short iron* is attacked more sharply than the kinds mentioned before. The surface becomes black very soon on account of the strong separation of carbon; after the acid has acted about ½ hour the coal can be washed off as a black slime; the exposed surface remains black even then. The surface is uneven and corroded, which can be observed plainly, when the metal is dried after about one hour's cauterizing and the file is applied slightly to the cauterized surface.

"*Puddle steel.* The color of the cauterized surface is a rather uniform gray.

"*Bessemer and cast steel* are attacked quite uniformly; defective places are found but rarely, and these do not show off to any great extent. The color is gray and increases in brightness with increasing softness of the steel. Fine fissures become visible after cauterizing.

"*Pig iron, cast iron and gray pig iron* conduct themselves similar to steel; the color of the cauterized surface is a uniform dark gray."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

3571. Cost of Copper Production. Ed. E. & M. J. (Editorial reply to twenty-two questions on vital points in the copper industry, covering detailed costs and items of interest to those commercially interested in copper). Eng & Min Jour–Jan. 11. 3900 w.

*3596. The Mechanical Testing of Iron and Steel. Professor Hudson Beare, in *Science Progress* (A scientific paper). Col Guard–Jan. 3. 4800 w.

†3605. A Proposed Schedule of Allowable Difference and of Probable Limits of Accuracy in Quantitative Analyses of Metallurgical Materials. E. D. Campbell (A valuable contribution giving, in tabular form, the variation usually allowed, and the limit of accuracy due to method, of all the substances usually determined in metallurgical work). Jour Am Chem Soc–Jan. 400 w.

*3631. Notes on the Treatment of Tailings by the Cyanide Process at the Standard Consolidated Mines, Bodie, California. Thomas H. Leggett (Paper read before the Inst. of Mining and Metallurgy. Detailed statement of time required, quantities, and values involved in the process are given, including cost of treatment, supplies consumed and value of products). Min Jour–Jan. 4. 400 w.

3641. Red Plastic Fire Clay. Charles Ferry (The writer states that a small percentage of iron oxide may be beneficial, as it makes the brick hard and tough). Ir Age–Jan. 16. 1600 w.

3642. The Troy Basic Bessemer Steel Plant (An illustrated description of the plant which is being built on a similar plan to the Pottstown, Pa., basic Bessemer plant). Ir Age–Jan. 16. 1000 w.

3655. Ore Treatment—Cyanide and Chlorination. W. P. Harvey (Giving interesting results obtained by both processes in the United States, and stating that the ores of British Columbia must be treated by these methods). Min & Sci Pr–Jan. 11. 2300 w.

*3669. The Extraction of Zinc from Its Ore. Henry W. Nichols (A general detailed description taken from the *Chicago Mining Review*). Aust Min Stand–Nov. 30. 1700 w.

3703. The Acetylene Mystery (Criticism of the claims of the various acetylene companies, especially on the cost of producing calcium carbide). Eng & Min Jour–Jan. 18. 2500 w.

3705. Special Device for the Elevating of Granulated Slag (A method of removing furnace slag. It is granulated by being run into water, raised by a special basket elevator and carried off in a sluice). Eng & Min Jour–Jan. 18. 400 w.

3729. Hamilton Smelting Works (Illustrated description of a new iron furnace plant). Can Eng–Jan. 1800 w.

*3731. Spontaneous Combustion of Coal (A discussion of the causes leading to the phenomenon with recommendations as to how this pyrophoric tendency of stored coal may be counteracted). Col Guard–Jan. 10. 900 w.

*3740. The Cyanide Process of Gold Extraction—Discovered 43 Years Ago. J. C. Montgomerie (Showing why the patents held should not be valid). Aust Min Stand–Dec 14. 1800 w.

*3741. The Preparation and Properties of Molybdenum. H. Moissan (From the *Bulletin de la Société de l'Encouragement de l'Industrie Nationale*. Description of method of making soft metallic molybdenum and also the carbide). Aust Min Stand–Dec. 14. 700 w.

*3743. Dry Crushing and Royalty (Considerations affecting the adoption of fine crushing and cyanide treatment of the entire mine output. 60% is estimated as being won by amalgamation at present in South Africa). Aust Min Stand–Dec. 14. 1200 w.

*3745. Remarks and Observations on the Cyanide Process. Walter J. Studds (Experiments on the effect of the addition of different alkalies to cyanide solutions, the extraction varying from 15 to 93 per cent). Aust Min Stand–Dec. 21. 1600 w.

We supply copies of these articles. See introductory.

3763. Treatment of Low Grade Ore. Edmund B. Kirby (Considerations which determine what process of ore treatment shall be selected for any given ore). Min & Sci Pr-Jan. 18. 3000 w.

3806. A Model Tin Plate Plant (Description of the Laughlin Nail Co.'s works, illustrated by three views of the machinery, and one plan). Met Work-Jan. 25. 900 w.

*3820. Microscopic Internal Flaws in Steel Rails and Propeller Shafts. Thomas Andrews (Attributing the failure of steel forgings when subjected to repeated stress to cavities filled with sulphide of iron, which are really microscopic flaws. The three sections shown illustrate this plainly). Engng-Jan. 17. 1600 w.

3869. The Kinkead Waste Rock Experiment (Illustrated description of a newly designed plant to treat waste gold ore from the dumps of a California mine. The ore treated runs about $4 per ton in gold). Min & Sci Pr-Jan. 25. 800 w.

3911. Semet-Solvay Retort Coke Ovens, with Recovery of By-Products. R. M. Atwater (From a paper read before the meeting of the Ohio Inst. of Min. Engs. Comparison of the Beehive oven coke with the Semet-Solvay product, with results of working). Ir Tr Rev-Jan. 30. 5000 w.

*3941. Burning Powdered Coal (Description, illustrated by two views, of the automatic feed used in a powdered coal furnace). Col Guard-Jan. 24. 1000 w.

*3942. Economic Conditions of the Iron and Steel Industry in Belgium and Germany (The official report just issued of the commission appointed by the British Iron Trade Assn. to investigate the comparative labor and industrial conditions on the continent). Col Guard-Jan. 24. 5000 w.

4006. The Smelting of Titaniferous Ores. A. J. Rossi (The general considerations, methods of treatment, and the properties of titanic minerals are fully discussed). Ir Age-Feb. 6. Serial. 1st part. 4200 w.

4042. The Amalgamation of Rich Free Gold-Ores. F. Hille (Relative economic results of ball-mill and mortar amalgamation in Transylvania. The former was run at about 1-10 the expense of the latter). Eng & Min Jour-Feb. 8. 1000 w.

4055. Open-Hearth Practice in Germany (A recent improvement, designed to evenly distribute the current of gases, consists of a transverse middle division wall in the regenerators). Ir Tr Rev-Feb. 6. 700 w.

4073. How to Distinguish Between the Different Kinds of Iron and Steel (Method of preparing specimen, and the appearance of the polished surfaces of each grade when etched with acid). Am Mfr & Ir Wld-Feb. 7. 700 w.

Mining.

3572. The Question of Extra-Lateral Rights. A. H. Wethey (A discussion of Court decisions, having the plan of claims and workings illustrated). Eng & Min Jour-Jan. 11. 2400 w.

*3614. The Loop Creek, West Virginia, Coal Field. Daniel W. Langdon (Its history, nature of the coal, how mined, its analyses, physical features). Col Eng-Jan. 1000 w.

*3667. The Mount Lyell Mining and Railway Company, Limited (Description embodying the report of the mine manager, engineers and metallurgists). Aust Min Stand-Nov. 30. 6000 w.

3702. The World's Greatest Gold Field. Dan de Quille (General review of the California gold fields). Min Ind & Rev-Jan. 16. 1400 w.

3711. The Methods of Prospecting for Gold in the South. William M. Brewer (Methods used in determining the extent of the deposits, and considerations affecting the method of mining and treatment of ore). Tradesman-Jan. 15. Serial. 1st part. 4400 w.

*3733. Periodicity of Fire-damp. A. Doneux (The writer states that fire-damp explosions follow sympathetically the hebdomadal fluctuation, and that it obeys the law of volcanic action). Col Guard-Jan. 10. 1800 w.

*3734. The Adhesive Properties of Coal. M. Louis Campredon (Brief extract from a paper read before the Académie des Sciences, Paris, on the relative coking properties of coals). Col Guard-Jan. 10. 500 w.

*3738. Mining Accident Relief Fund (A scheme to provide for accidents to miners). Aust Min Stand-Dec. 7. 600 w.

*3739. Deep Level Mines. L. J. Seymour (Some notes on the Lake Superior copper mines). Aust Min Stand-Dec. 7. 3300 w.

*3742. The Underground Workings of Broken Hill Block 10 Silver Mine (Illustrated description from the report of the general manager). Aust Min Stand-Dec. 14. 1900 w.

*3744. Physiography and Geography of the Wadnaminga Gold Fields, South Australia. F. D. Johnson (Paper read before the Australian Inst. of Min. Engs. An extended description). Aust Min Stand-Dec. 14. Serial. 1st part. 3400 w.

*3746. The Principles and Practice of Mining and Ore Dressing on the Zeehan Field. E. Moriarty Weston (An excellent description of practice in Tasmania). Aust Min Stand-Dec. 21. 4000 w.

*3747. Mount Bischoff Tin Mine (Tasmania) (Description with illustrations of the Red Face and the Brown Face workings). Aust Min Stand-Dec. 21. 500 w.

†3765. The Coolgardie Gold Fields, West Australia. A. T. F. (A true description of this much talked of Western Australian district, by one who has been there. Illustrated by a map). Ind Engng-Dec. 21. 2200 w.

3779. Mexican Mining Operations Creating a Market for American Machinery. E. L. (Information as to the situation and character of some of the principal mines in Mexico). Mfrs Rec-Jan. 24. 1300 w.

3788. 100-Ton Derrick at the Avondale Marble Quarries, Chester, Pa. (Illustrated description of derrick and method of working quarry). Eng. News-Jan. 23. 800 w.

We supply copies of these articles. See introductory.

3809. Camp Floyd District, Utah. James W. Neill (The gold production of the Mercer and adjoining districts is $2750 daily). Eng & Min Jour-Jan. 25. 2800 w.

3810. The Salt Creek Oil Field, Wyoming. Wilbur C. Knight (A description with seven illustrations. The probable production in 1896 is put at 5000 barrels). Eng & Min Jour-Jan. 25. 1200 w.

*3826. The New Perforators. Ill. Léon Thiriart (A paper read before the Assn. of Min. Engs. at the Liège School, and translated from *La Revue Universelle des Mines, de la Métallurgie, &c.* These screw feed drills are intended to displace power drilling and blasting in fire damp coal mines). Col Guard-Jan. 17. 2500 w.

3904. The Oriskany Iron Ores at Rich Patch Mines, Va. Edmund C. Pechin (General description). Eng & Min Jour-Feb. 1. Serial. 1st part. 1400 w.

3910. Wire Rope Haulage, Its Use and Abuse. T. E. Hughes (Read at Columbus, O., before the Ohio Inst. of Min. Engs. The author points out the superiority of standard over long lay wire ropes and the influence of friction on the life of the rope, with some notes on haulage systems). Ir Tr Rev-Jan. 30. 2400 w.

*3940. Water Cartridges in Blasting. L. Jaroljmek (Water is used as tamping and acts at the same time on the quicklime termination of the dynamite cartridge, generating sufficient heat to fire the fulminate cap). Col Guard-Jan. 24. 2000 w.

3957. The Trail Creek Gold Mining District of British Columbia. J. D. Sword (General description). Can Min Rev-Jan. 4500 w.

†4000. The Mines and Plant of the El Carmen Mining Company, Villaldoma, Mexico. Harrison Souder (A description of the silver mines, sampling the ore, ventilation of the workings, water supply, and the company railroad. The article is well illustrated). Pro of Eng's Club of Phila-Jan. 5000 w.

4015. The Auriferious Gravels of British Columbia. J. M. Buxton (Some mining experiences in working the British Columbia hydraulic gold deposits). Mining-Jan. 2000 w.

4016. The Slocan Country. Charles F. Caldwell (Brief notes on existing mines in this district of West Kootenay, B. C.). Mining-Jan. 2200 w.

4017. Hallidie Ropeway at Halls Mines, Nelson, B. C. Ill. (A steel cable ropeway, carrying ore four and one-half miles, carrying 900 traveling buckets, holding 100 lbs. each. The system is automatic). Min & Sci Pr-Feb. 1. 700 w.

Miscellany.

†3606. An Electrolytic Method for the Determination of Mercury in Cinnabar. W. B. Rising, and Victor Lenher (The cinnabar is dissolved in hydro-bromic acid, neutralized with caustic potash, pure cyanide of potash added in excess to dissolve precipitate, and the metallic mercury deposited on platinum by a weak electric current). Jour Am Chem Soc-Jan. 400 w.

3615. Norwegian Minerals Containing Thorium and Yttrium. L. Schmelck (These minerals are important by reason of the incandescent properties of their oxides). Am Mfrs & Ir Wld-Jan. 10. 800 w.

3656. Balance Sheet of a South African Mine (Itemized official statement). Min & Sci Pr-Jan. 11. 200 w.

*3668. Suggestions as to Building a Mill (Considerations affecting the location of a stamp mill). Aust Min Stand-Nov. 30. 800 w.

3704. The Transvaal Crisis (Short history, with portraits of the principal actors in the Transvaal—viz.: Messrs. Kruger, Rhodes, Williams, Barnato, Jameson, and Hammond). Eng & Min Jour-Jan 18. 1300 w.

*3730. Mineral Resources of Spain. Reginald W. Barrington (A condensed description). Ind & Ir-Jan. 10. Serial. 1st part. 800 w.

*3737. Geology of Central Australia (Description of explorations made by the South Australian government geologist, with special reference to mining deposits). Aust Min Stand-Dec. 7. 2300 w.

*3748. The Origin of Malachite. Edgar Hall (Observations in an abandoned copper mine leading to a theory of formation of copper carbonates). Aust Min Stand-Dec. 21. 1300 w.

3764. Venezuela, Its Industry, Mining and Commerce. I. B. Storch (The mineral deposits are undeveloped, as prospecting, owing to the dense underwood, is difficult. The annual production of gold was 180,000 ounces). Min & Sci Pr-Jan. 18. 900 w.

3808. The Transvaal Troubles (A condensed statement of the causes leading to the revolt and notes on the present situation. A readable editorial). Eng & Min Jour-Jan. 25. 2300 w.

*3825. The Mineral Industry of the United Kingdom (First annual general report upon the mineral industry). Col Guard-Jan. 17. Serial. 1st part. 5500 w.

†3907. The Building Stones of the United States. Dr. William C. Day (Distribution, methods of quarrying and general characteristics of the stones produced at present for structural purposes). Jour Fr Inst-Feb. 6000 w.

*3935. "That Flood of Gold." Carl Snyder (Popular, interesting description of methods in modern gold mining, with remarks upon probable effect of the great increase in gold production). Rev of Rev-Feb. 4000 w.

†4064. Topography, Climate, and Mineral Springs of Alabama. A. N. Bell (The article contains analyses of a number of the mineral waters of the state and a complete list of the springs; also facts in relation to the advantages of the state as a winter resort). San-Feb. 2400 w.

†4070. The Precipitation of Phosphomolybdate in Steel Analysis. George Auchy (Experiments tending to prove that dilute solutions and the presence of ammonia nitrate are essential conditions for complete precipitation). Jour of Am Chem Soc-Feb. 1000 w.

MUNICIPAL ENGINEERING

Determination of Nitrites in Water.

CERTAIN discrepancies (very marked in the case of peaty waters) having been found to exist between Trommsdorff's iodo-zinc starch method and Griess's *a*-napthylamine test upon a large variety of waters, Mr. Augustus H. Gill, conjointly with Mr. H. A. Richardson, has contributed to *Journal of the American Chemical Society* for January a method of decolorizing peaty waters so that agreement between these standard tests is obtained.

"The peaty waters showed no blue by Trommsdorff's method, but in some cases as high as 0.001 parts nitrogen as N_2O_3 per 100,000 by the Griess test. Upon decolorizing the waters, the results agreed, showing that the peaty matter interferes with the formation of the iodid of starch, and, unless nitrites are present in considerable quantity (above 0.002 parts nitrotrogen as N_2O_3 per 100,000), this test is not capable of detecting them.

"The decolorization was effected in the cold, as heating increases the nitrites, by shaking up about 250 cc. of the water with three cc. of 'milk of alumina' (prepared by precipitating a boiling solution of potash alum with ammonia, etc.), allowing to settle, and filtering through a filter which is washed free from nitrites. Even when using Griess's method, it was found advantageous to decolorize the peaty waters, as their brown color modifies the pink tint, giving a slightly higher reading than would otherwise be obtained."

A table given by the author shows the effects of the peaty matter, and also a comparison of the methods, together with that of the *m*-phenyldiamine, which table is not in convenient form for reprinting in this review. With reference to the results the author says further:

"In some cases a pink color was obtained and no blue, due probably to the greater delicacy of the naphthylamine test, it being competent to detect 0.0001 parts of nitrogen as N_2O in 100,000. This, we think, is the extreme limit of the test, as different shades, not *depths*, of color are obtained upon adding different quantities of the reagents, as Dr. J. T. Tanner found. The iodo zinc starch method is incapable of detecting less than 0.0002 parts of nitrogen as N_2O_3 per 100,000.

"In a few cases the blue color appeared, but no pink; but, upon passing carbon dioxid through the water, no blue was obtained. This may possibly have been due to hydrogen peroxid. Where large quantities of nitrites are present, a purple color, instead of a blue, is obtained, which is difficult to estimate; in such cases the water should be diluted before applying the test.

"In conducting the Griess test, the directions given by Dr. Tanner were followed, with the additional precaution of using water free from nitrites in the preparation of the reagents. This was prepared by distilling the middle portion of ordinary distilled water with an excess of alkaline permanganate, collecting the middle portion of the distillate thus obtained. Water prepared in this way gives no test upon eighteen hours' standing, even when tightly stoppered."

Computation Table for Flow in Sewers.

MR. ANDREW ROSEWATER, member of the American Society of Civil Engineers, and city engineer of Omaha, writes to *Engineering News* (Jan. 16), that references made to certain features of the city reports for 1893-4 have resulted in a multitude of applications for copies, which cannot now be supplied, as the edition is exhausted.

One of the features which excited the demand was a table for computing flow in sewers. In order that it may be made as widely available as possible, Mr. Rosewater sent the table to the *Engineering News*, which reprinted it, together with the letter accompanying it. In furtherance of the same object, we too herewith reprint this useful table, with an explanation

whereby its application can be easily understood.

Method of using the table:

To find the velocity and discharge of a 3 ft. 8 in. sewer on a 2.25% grade. Find the velocity and discharge as given in the table opposite 3 ft. 8 ins. and multiply them by the square root of 2.25.

Thus 11.05 multiplied by 1.5 equals 16.57, the required velocity.

Thus 116.8 multiplied by 1.5 equals 175.20, the required discharge.

When the velocity and discharge are desired for different values of n than (n equals .013), very good approximate values can be deduced as follows:

For n equals .011, multiply tabular quantities by 1.20.

For n equals .012, multiply tabular quantities by 1.09.

For n equals .015, multiply tabular quantities by 0.84.

For n equals .017, multiply tabular quantities by 0.73.

These can be used with a limit of error of 10%, and it is only in the extreme cases where the error exceeds 5%.

The above approximations give excessive values for small diameters and insufficient values for large diameters.

Table of Velocity and Discharge of Circular Conduits Based on Kutter's Formula. n. equals .013. Grade equals 1 in 100 (or s equals .01).

Diam. of Conduit.		Veloc. in ft. per sec.	Disch. in cu. ft. per sec.	Diam. of Conduit.		Veloc. in ft per sec.	Disch. in cu. ft. per sec.
Ft.	In.			Ft.	In.		
	4	1.81	0.16	7	0	16.98	653.4
	6	2.52	0.49		3	17.37	717.2
	8	3.17	1.11		6	17.77	785.1
	9	3.47	1.53		9	18.12	854.7
	10	3.77	2.05	8	0	18.50	930.0
1	0	4.34	3.40		3	18.87	1008.9
	3	5.12	6.29		6	19.25	1092.4
	6	5.87	10.37		9	19.57	1177.1
	8	6.35	13.85	9	0	19.94	1268.6
	9	6.57	15.79		3	20.29	1363.7
	10	6.80	17.94		6	20.65	1463.7
2	0	7.24	22.74		9	20.96	1565.0
	2	7.67	28.27	10	0	21.31	1673.7
	4	8.08	34.53		3	21.65	1786.2
	6	8.48	41.64		6	21.99	1903.9
	8	8.88	49.59		9	22.28	2022.7
	10	9.26	58.63	11	0	22.62	2149.6
3	0	9.63	68.09		3	22.94	2280.5
	2	10.00	78.78		6	23.27	2417.0
	4	10.36	90.39		9	23.56	2554.3
	6	10.71	103.00	12	0	23.88	2700.5
	8	11.05	116.80		3	24.50	2850.8
	10	11.39	131.50		6	24.50	3007.0
4	0	11.73	147.40		9	24.77	3163.6
	2	12.07	164.50	13	0	25.09	3329.9
	4	12.39	182.70		3	24.19	2850.8
	6	12.71	202.20		6	25.69	3677.3
	8	13.01	222.40		9	25.95	3854.3
	10	13.31	244.20	14	0	26.25	4041.9
5	0	13.62	267.50		6	26.84	4432.2
	2	13.94	292.10	15	0	27.39	4839.9
	4	14.23	317.80		6	27.95	5274.5
	6	14.535	345.10	16	0	28.48	5726.8
	8	14.78	373.00		6	29.03	6208.4
	10	15.07	402.80	17	0	29.55	6707.1
6	0	15.36	434.30		6	30.08	7236.3
	3	15.78	484.20	18	0	30.58	7783.1
	6	16.20	537.70	19	0	31.59	8958.4
	9	16.57	593.10	20	0	32.58	10236.0

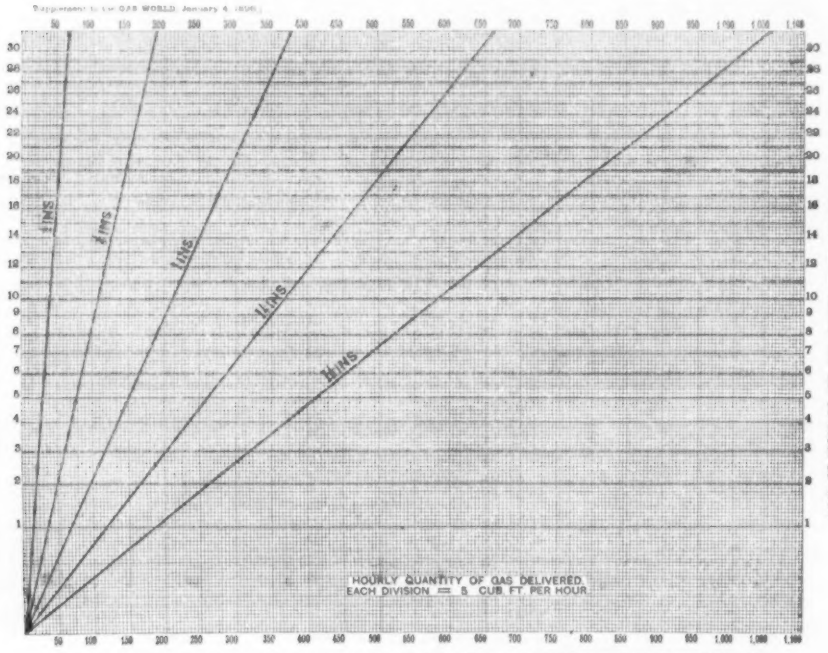
Table of Grades per 100 and their Square Roots.

Grade per 100.	Square Root of Grade.	Grade per 100.	Square Root of Grade.	Grade per 100.	Square Root of Grade.
.04	.200	1.20	1.095	3.15	1.775
.05	.224	1.25	1.118	3.20	1.789
.06	.245	1.30	1.140	3.25	1.803
.07	.265	1.35	1.162	3.30	1.817
.08	.283	1.40	1.183	3.35	1.830
.09	.300	1.45	1.204	3.40	1.844
.10	.316	1.50	1.224	3.50	1.871
.11	.332	1.55	1.245	3.60	1.897
.12	.346	1.60	1.265	3.70	1.924
.13	.361	1.65	1.285	3.80	1.949
.14	.374	1.70	1.304	3.90	1.975
.15	.387	1.75	1.323	4.00	2.000
.16	.400	1.80	1.342	4.20	2.049
.17	.412	1.85	1.360	4.40	2.098
.18	.424	1.90	1.378	4.60	2.145
.19	.436	1.95	1.396	4.80	2.191
.20	.447	2.00	1.414	5.00	2.236
.22	.469	2.05	1.432	5.20	2.280
.24	.490	2.10	1.449	5.40	2.324
.26	.510	2.15	1.466	5.60	2.366
.28	.529	2.20	1.483	5.80	2.408
.30	.548	2.25	1.500	6.00	2.449
.35	.592	2.30	1.517	6.50	2.550
.40	.632	2.35	1.533	7.00	2.646
.45	.671	2.40	1.549	7.50	2.739
.50	.707	2.45	1.565	8.00	2.828
.55	.742	2.50	1.581	8.50	2.915
.60	.775	2.55	1.597	9.00	3.000
.65	.806	2.60	1.612	9.50	3.082
.70	.837	2.65	1.628	10.00	3.162
.75	.866	2.70	1.643	11.00	3.317
.80	.894	2.75	1.658	12.00	3.464
.85	.922	2.80	1.673	13.00	3.606
.90	.949	2.85	1.688	14.00	3.742
.95	.975	2.90	1.703	15.00	3.873
1.00	1.000	2.95	1.718	16.00	4.000
1.05	1.025	3.00	1.732	17.00	4.123
1.10	1.049	3.05	1.746	18.00	4.243
1.15	1.072	3.10	1.761	20.00	4.472

Delivering Capacity of Gas Mains.

THE determination of the delivery of gas through mains has hitherto involved a considerable amount of calculation. Mr. Lewis T. Wright has contributed to *The Gas World* a series of diagrams,—the first of which is herewith reproduced,—whereby the flow can be determined without the labor of calculation. The diagram thus presented enables the flow of gas having a specific quantity 0.4 to be determined for service pipes of ¼, ½, 1, 1¼, and 1½-inch diameter.

Although these diagrams are drawn for fixed distances of 100 and 1,000 yards, respectively, they are readily available for any distance in the following manner: the maximum loss of pressure that can be allowed for any given distance having been decided upon, it is easy to calculate the



LEWIS T. WRIGHT'S DIAGRAMS SHOWING DELIVERY OF GAS BY PIPES AND LOSS OF PRESSURE AT POINT OF DISCHARGE—**No. 1.**

It is not our intention to present the other diagrams for larger sizes of pipes in this department, as they will appear subsequently in *The Gas World*, but, as they are useful and of interest to gas engineers, we call attention to them in this review.

The following explanation will render easy the general application of the diagrams:

"The vertical lines show the hourly quantity of gas delivered. The horizontal lines show the loss of pressure per 100 yards in the case of diagrams 1 and 2, and per 1,000 yards in the case of Nos. 3 and 4 and 5, in the complete set of five diagrams. The inclined lines represent the pipes or mains, according to their diameters in inches.

loss per 100 or 1,000 yards. Thus, if the allowable loss of pressure be 20 tenths for a distance of 2,000 yards, the loss per 1,000 yards will be 10 tenths, and the loss per 100 yards will be 1-tenth, because the loss of pressure is proportional to the distance."

When the maximum quantity of gas to be delivered, the distance to which it is to be transported, and the maximum loss of pressure, are known, the diagram will give at a glance the size of pipe that will meet the requirements.

By these diagrams, also, the loss of pressure may be found when the size of the main, the quantity of gas delivered, and the length of main are given; and, when the length of main, its diameter, and the loss of pressure are known, the quantity that will be delivered may be as readily ascertained.

The diagrams will be useful also to those who are installing gas engines of considerable size.

The Carbid of Calcium Industry.

DR. W. H. BIRCHMORE in *Engineering News* (Jan. 30) has contributed the most able essay upon carbid of calcium, in its relation to the future of gas lighting, that we have met. As to the Wilson and the Morehead patented methods, he thinks "it would be an amusing result if an attempt, which will surely be made, to overthrow the Wilson patent should result in making the manufacture free to all the world." And he states that "it is now the opinion of practically all patent lawyers who have examined the question that the Wilson patents are waste paper." The following quotation from Dr. Birchmore's paper is significant.

"The more this substance is studied, the more plainly it appears that there is room for much yet to be learned concerning the manufacture. Many are the scientific and practical problems involved, as has been demonstrated in repeating the experiments of all interested, from Wohler to Moissan. I beg leave to affirm that, in addition to the CaC_2 union, there are certainly others, and one of them seems to be more frequently produced by the Cowles process than by the Wilson. Incidentally it may be mentioned that a number of pounds of alleged carbid made by the Cowles process came into my hands, which would yield neither ethine, methane, nor hydrogen. Still more singular were some of the vagaries of the samples made in North Carolina by the Morehead connection."

With reference to the mode of preparation he says: "In all the patents issued to Wilson is shown a furnace which is identical in all respects with the classic Siemens type, and in the articles in the *Gas Light Journal* the same appears. It is the Siemens furnace with a part of his drawing left out and the balance disfigured; the electric governing apparatus is omitted. The implied purpose is to show the way in which carbid is manufactured. Now, in point of fact, there has not been one pound of carbid made in this way, and in the judgment of some lawyers, and good ones at that, the performances of the Morehead connection in using and exhibiting, as a commercial process of making carbid, a method not protected, and trying to sell the same, has brought in conditions surrounding the problem that will make plenty of trouble for the 'innocent purchaser' after the latter has made carbid a commercial success. In the method in actual use there is no crucible, but an open hearth in which the material is piled and subjected to the current; and, as the center of the pile melts under the heat, pieces of boiler iron are set about so that the pile may be built higher.

"The rapid cooling at the surface makes a column of fused amorphous carbid with a crystalline center in the midst of a heap of uninfluenced lime and coke, built up between two vertical electrodes, one of which is constantly retreating. To call this an operation protected by the Wilson patents exposes one to contradiction.

"Be this as it may, I, personally, in laboratory experiments, have made carbid as follows: (a) by the Wilson patent method; (b) by the Morehead patent practical unpatented method; (c) in a furnace using Cowle's methods of working; (d) by the Clarke patent methods; (e) by the unpatented method of Moissan; and from these studies I have found that modifications of Moissan's multiple arc furnace will produce the carbid even more cheaply than the Morehead method."

The paper concludes with the following significant paragraphs:

"There are two directions in which improvements can be made. The burners can be improved so that, in place of a consumption of 1.4 cu. ft. and a 64-c. p. (B P.) unit, a consumption limited to 0.43 cu. ft. and 20-c. p. unit shall be

reached. This would instantly bring the value of a ton of carbid up to the promoter's figures, and make the Morehead h. p. value 4.48 cts. per h. p. hour. At the same time an increase in the efficiency of the furnaces to say 80%, which is, I am told, the efficiency of the Herault process, would raise the product to 27 lbs. per h. p. day at the dynamo.

"Either one of these improvements would put ethine in the market as a rival for coal gas, electric lighting, and even the common kerosene oil lamp.

"More than a dozen expert men are working on these problems, and any day the much-wanted burner may come to hand, and with it a revolution in the financial status of those who will doubtless appreciate the advantage of being first in a commercial field.

"Once given a burner which will burn ethine properly, and carbid industries will spring up all over the country, without any bubble-blowing or professional promotion. There will not only be a carbid industry, but a great many carbid industries."

MR. L. L. BUCK, chief engineer of the new East River Bridge to connect New York and Brooklyn says that if trolley cars are to be used on the bridge as has been proposed, they must, under present conditions, be run singly, or with motor cars and four trailers. This service would be inadequate during crowded hours, and hence the engineer thinks that two tracks in the direction of travel would be needed. He thinks the best arrangement would be placing two elevated road tracks in the center and two trolley tracks on each side of them. This would make six tracks in all. It is thought that with this arrangement proper cross-overs can be made for each set of tracks, and that it will undoubtedly afford all the facilities needed for a long time.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*3563. A Retrospect of the Year 1895 (Review of the gas industry for the year). Jour Gas Lgt–Dec. 31. 4700 w.

*3566. Coal Carbonizing in Bulk at Lancaster (Treats of the system of coal carbonizing in bulk, with recovery of all products and with special reference to a plant installed at Lancaster, a view of the works being also given. An instructive and interesting article). Jour Gas Lgt–Dec. 31. 2500 w.

*3567. A Spectroscopic Study of Oxy-Coal Gas (An investigation by M. Jean S. Stas). Jour Gas Lgt–Dec. 31. 1100 w.

*3589. The Delivering Capacity of Gas Mains (Diagrams for blow of gases of different specific gravities) Gas Wld–Jan 4. 1100 w.

3674. Calcic Carbide Plant at Niagara Falls, Ill. Orrin E. Dunlap (The product of this initial plant will be sent to Philadelphia in barrels and there manufactured into acetylene gas to supply southern Pennsylvania). W Elec–Jan. 18. 1200 w.

3728. Calcium Carbide and Acetylene (Additional information about the substances, and the industrial results likely to proceed from the discovery of the Wilson process of making calcium carbide). Can Eng–Jan. 2500 w.

†3802. Gaseous Compounds of Iron and Nickel with Carbonic Oxide and their Curious Effects on Burner-Tips, etc. Henry Morton (Causes of the mushroom shaped deposits on burner tips experienced in the use of water gas, and their chemical composition). Stevens In–Jan. 1200 w.

*3835. Destructive Distillation. R. Tervet (Paper read before the Scottish Soc. of Chem. Ind. Discusses the subject from the standpoint that no matter to what extent a crude distillate may vary in the relative proportions of its ingredients, it always has a destructive character). Gas Wld–Jan. 18. 2400 w.

†3844. Acetyline (The story of the discovery, with some consideration of its value). New Sci Rev–Jan. 1300 w.

3857. Some Facts About Acetylene Gas. John C. McMynn (Read before the Northwestern Electrical Assn., Milwaukee. Followed by an abstract of the discussion). Elec Rev–Jan. 29. 3000 w.

3882. Acetylene Gas (An abstract of an article on this subject appearing in the *N. Y. World* of Jan. 26, with brief notice of a paper on the same subject by Prof. Crafts). Elec Wld –Feb. 1. 2000 w.

3884. Calcium Carbide and Acetylene (Editorial, commenting on the commercial methods by which these products are sought to be introduced, and upon views of experts regarding them). Engng News–Jan. 30. 2200 w.

3886. Will there Be a "Carbide" Industry? Dr. W. H. Birchmore (Opinions of a well known expert. The history of the chemistry of calcium carbide and acetylene is given and the five different methods of producing carbide of calcium are reviewed, two only of which are patented.

We supply copies of these articles. See Introductory.

The history of the present acetylene boom is also given. Methods of using the material and its properties are discussed, and the Wilson patents are declared simply waste paper so far as their protection of the monopoly of manufacturing calcium carbide is concerned. The extreme probability of a revolution in gas lighting by the supply of needed improvements in the manufacture of calcium carbide, and the supply of a proper burner for it, is admitted). Engng News-Jan. 30. 5000 w.

*3891. The Effect of Atmospheric Conditions on the Hefner and Pentane Standard Lamps (Atmospheric conditions noted as adversely effecting the illumination of the lamps named are presence of moisture and carbonic acid, diminution of atmospheric pressure, and diminution of oxygen. Experiments to determine quantitatively these effects are described, and the results are given). Jour Gas Lgt-Jan. 21. 3000 w.

4036. Acetylene (Objections to use of acetylene in the liquid form). Eng Rec-Feb. 8. 500 w.

Sewerage.

3610. Sewer Excavating Machinery (Illustrated detailed description). Eng Rec-Jan. 11. 500 w.

3654. A Table for Computing Flow in Sewers (A very useful table with description of method of applying it). Eng News-Jan. 16. 600 w.

*3832. Sewage Disposal at Salford (General description with sketch plan). Eng, Lond-Jan. 17. 2300 w.

4037. A Portable Sewer-Flushing Apparatus (Illustrated description of apparatus used in New Haven, Conn., whereby work that used to require from eight to ten days is now performed in two or three hours). Eng Rec-Feb. 8. 900 w.

4038. The Sewer Outfall at Ithaca, N. Y. Ill. An interesting example of cheap and easily constructed work, designed by Mr. Rudolph Hering). Eng Rec-Feb. 8 400 w.

Streets and Pavements.

3995. Comparative Value of Side Cut, End Cut and Repressed Brick for Street Paving. T. C. Tridell (Advantages and disadvantages of each class. A good, practical paper). Brick-Feb. 1300 w.

*3997. Recent Discussions of Asphalt (General review of some of the latest literature of the subject). Pav & Mun Eng-Feb. 2500 w.

Water Supply.

*3564. Water and Sanitary Affairs (The principal events of the year 1895). Jour Gas Lgt-Dec. 31. 3000 w.

3575. The Reading, Pa., Water Supply (The first part is historical and statistical with brief references to two sources of present supply). Fire & Water-Jan. 11. Serial. 1st part. 1300 w.

†3604. Notes on the Determination of Nitrites in Potable Water. Augustus H. Gill, and H. A. Richardson (The presence of peaty matter having caused discrepancies in the results obtained by Trommsdorff's iodo-zinc starch method, and Griess' α-naphthylamine test, this article formulates a method whereby peaty waters may be decolorized, and the results of the two tests thus made accordant). Jour Am Chem Soc-Jan. 400 w.

3657. Cedar River Gravity Water Supply for the City of Seattle, Washington (History of the enterprise). Min & Sci Pr-Jan. 11. 1500 w.

3699. Consumption and Waste of Water. Dexter Brackett (A paper read at the annual convention, and reprinted from the Trans. of Am. Soc. C. E. Detailed statistics and general remarks. Causes and prevention of waste also considered). Eng Rec-Jan. 18. Serial. 1st part. 2000 w.

*3866. On the Bacterial Contents of Certain Ground Waters Including Deep Wells, Boston. W. T. Sedgwick (Describes experimental investigations of numerous springs, wells and deep wells, with reference to their containing germs of bacteria. Results show the water from wells and springs may contain more bacteria than water from lakes). San Rec-Jan. 17. 2200 w.

*3892. The Municipal Water Supply of Cologne (Illustrated detailed description of an interesting subject. Elevation and plan of boiler-house and pumping station are given in first part). Jour Gas Lgt-Jan 21. Serial. 1st part. 2200 w.

†4069. Chemical vs. Bacteriological Examination of Potable Water W. P. Mason (The depreciation of chemical examination in favor of bacterial, is criticised as having gone too far, and it is maintained that while both methods are valuable, there are cases depending upon special conditions, in which either of these methods might be more reliable than the other). Jour of Am Chem Soc-Feb. 800 w.

Miscellany.

†3561. Sewerage and Street Cleaning of Vienna. Max Judd (From report to State Department. An interesting description of means and methods). San-Jan. 2000 w.

*3593. The Bath Refuse Destructors. (Illustrated detailed description). Engng-Jan. 3. 1300 w.

3637. Municipal Art Again (Editorial, treating of the improper expenditure of money that ought to contribute to the beauty of a city). Gar & For-Jan. 15. 1200 w.

*3841. Notable Sanitary Experiments in Massachusetts. W. T. Sedgwick (The work accomplished by the State Board of Health of Massachusetts, chiefly in the direction of water supply and sewerage). Forum-Feb. 6500 w.

4018. The First Calcic Carbide Plant. Orrin E. Dunlap (Illustrated description of the works recently erected at Niargara Falls for the manufacture of calcic carbide). Min & Sci Pr-Feb. 1. 1300 w.

4023. The Johnson Garbage Crematory (Illustrated description of the experimental crematory at Chicago, Ill., with an account of its performance in recent tests. The expense of cremation has been found to be 28.2 cents per ton). Eng News-Feb. 6. 1000 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

Emergencies in Railroad Work.

To the *Bulletin of the University of Wisconsin, Engineering Series* (Dec.), Mr. L. F. Loree contributes a very interesting lecture on his personal experiences in railroad wrecks, washouts, strikes, etc. After describing the equipping of wreck trains, their provisioning, and the character of the emergencies to be met, he continues, quoting the practice of the C. & P. division of the Pennsylvania Railroad Company as follows:

"We have found it convenient to have a crew consisting of a foreman and twelve men. These men are employed about the shops where the car is kept, and work at car repairs. Should one, for any reason, desire to absent himself from his duties, permission is first obtained of the foreman, who designates another to fill the vacancy, so that a full complement of men is always assured. Should the wreck occur during working hours, the crew is advised of it by whistle signal; if at night, by electric bells located in their homes.

"There is a similarity between the service of the wreck train and that of a city fire department. The value of the service is greatly dependent upon the quickness with which the apparatus is got on the ground. So, when the signal sounds, every man hastens to his place; the most available engine and crew are pressed into the service, regardless of their previous engagements; once started, they are given a clear track to the point of obstruction; other trains scurry in on the lie-bys, very much as travelers seek the sidewalks and teams the curb as the ringing of the fire gong announces the approaching truck. Arriving at the wreck, a telegraph office is hooked up, the train wire cut in, and communication established with headquarters. A man is left in charge of the tool car, who issues the tools as they are called for, and cleans and puts them away in order as they are returned. He also keeps the coffee-pot boiling and serves up a luncheon of biscuits, tinned meats, etc. Again, as at a fire the chief effort is to prevent its spread, so here the effort is not so much to save the damaged cars as to clear the line for the movement of traffic. Nearly everything is rolled down the bank; the picking up is postponed to a more convenient season or the all-accommodating Sunday. Meantime, much has been done in other directions. The party calling for assistance is required to supplement his call with a description in some detail of the situation, and an estimate of the probable time required to clear. If this be more than four hours, no more freights are despatched from terminals, but effort is concentrated upon marshalling trains and clearing up the yard tracks to take care of the concentrated movement which must follow the resumption of business. If the estimate is for less than four hours, the trains are moved up as close as possible to the wreck, and so put away on the sidings that, when the movement is resumed, the knot will easily untie. Meantime arrangements are making for detouring mail trains over foreign lines, and around the obstruction, or for transferring by the same from train to train. Altogether there is a fine activity, which is but feebly set out in the records of the C. & P. Division, from which I have compiled the following tables.

AVERAGES OF TIME, 1890 to 1894.

No. times called, day	33
" " " night	22
Time between call and start, day	15 min.
" " " " " night	24 "
" running to wreck	36 "
" in cleaning away wreck	2 h. 2 "

Minimum time between call and start.

Year.	6 a. m. to 6 p. m.	6 p. m. to 6 a. m.
1890	5 min.	13 min.
1891	2 "	8 "
1892	3 "	8 "
1893	5 "	5 "
1894	5 "	13 "

Speaking of the efficient manner in which the railroads handled the strike in 1894, the author concludes: "Whether we regard the action of their management, dignified in the maintenance of their rights,

disdainful of compromise with the wrong-doer, steadfastly holding their course through this troubled sea; or the conduct of their men, moving in small and isolated groups, quietly and indomitably, to the performance of their duties, amid the howlings of the mob,—there stands revealed an institution and a spirit that may well give heart to them that love the Republic when any similar movement threatens the destruction of established order."

Mileage of European Railways.

THE opinion has been expressed that the United States has built all the railways that will be needed. However this may be, Europe, with its network of operating lines, still finds it necessary to add to this means of transportation. In *The Railway Age* (Nov. 15.) will be found the following official information:

"The bureau of railways of the French government has published a statement of the railway mileage in each country in Europe on the 31st of December, 1894, with comparions for the previous year, from which, as printed in *Le Journal des Transports*, we obtained the following figures, after converting kilometers with miles:

COUNTRY.	Miles of Railway.	Increase in 1894.
Germany	28,317	469
Austria-Hungary	18,662	545
Belgium	3,445	44
Denmark	1,408	22
Spain	7,547	412
France	24,738	385
Great Britain and Ireland	20,863	224
Greece	568	.....
Italy	9,087	274
Netherlands	2,657	4
Luxembourg	261	.....
Portugal	1,456	3
Roumania	1,603	5
Russia	20,699	1,212
Finland	1,383	87
Servia	335	.....
Sweden	5,737	280
Norway	1,068	67
Switzerland	2,160	33
Turkey, Bulgaria, and Roumelia	1,218	119
Isles of Malta, Jersey, and Man	68	.....
Total	152,209	4,212

"While railway building continues in the old and finished countries, it certainly is not likely to cease in this new land, with vast areas still poorly supplied with transportation facilities. Even the percentage of increase experienced by Europe last year would have given this country over 5,000 miles, instead of the little more than 2,000 miles which were credited to 1894,—the period of smallest construction in about thirty years. The rate of increase last year in Turkey and its provinces was 1.05 per cent., in Finland 6.70 per cent., in Russia 6.22 per cent., in France 6.22 per cent., in Sweden 5.14 per cent., in Italy 3.11 per cent., in Austria-Hungary 3.01 per cent., while in the United States it was only 1.23 per cent.,—a remarkable contrast to previous records, and a contrast which is not likely to be often repeated."

Apropos of the above, and as showing the state of American railroad construction, we quote the following from *The Railway Age* (Dec. 27):

"The rapid decrease in railway building in the United States in the last years may be seen by the following figures from our record of actual construction:

1887	Track laid,	12,983	miles.
1888	" "	7,106	"
1889	" "	5,230	"
1890	" "	5,670	"
1891	" "	4,281	"
1892	" "	4,192	"
1893	" "	2,635	"
1894	" "	1,949	"
1895	" "	1,782	"

"The bottom has been reached, and a moderate revival of railway building may be looked for. Materials are exceedingly cheap, labor is abundant, practical enterprises are numerous and on some of them much work has been done, business is reviving in spite of terrific assaults from political and speculative quarters, and the needs of many localities for greater transportation facilities must be met. It is true that the remarkable development of electric railway building has had a repressive effect upon not a few local projects; but for transportation lines of any considerable importance the steam locomotive does not yet recognize any competition, and the building of steam railways is still to go on, although the pace of former years may not again be equaled.

"The railways of the United States on December 31, 1895, will aggregate a little over 181,000 miles."

Roadbed Construction for Street Railways.

FROM an article appearing in the *Street Railway Journal* (Jan.) on the present practice in street railway work, we extract the following comments, with cuts representing the present typical forms of road-bed construction:

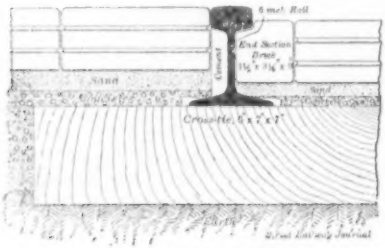


FIG. 1.—T RAIL ROADBED.

"The old horse railway track construction, with its flat, side-bearing rails spiked down to longitudinal stringers, has gone by forever. In its place have come forms of construction which almost equal in solidity the standard roadway construction of our best steam railroads. With the latest and best forms of street railway track construction, we are confidently looking for a life of at least eight or ten years before complete renewals will become necessary through pounding down of joints, rotting of ties, or wearing away of the head of the rail.

"The use of concrete as a substructure for track construction is not as general in America as abroad, although in the principal cities of Canada and a few in the United States it has been used with excellent results, giving much greater solidity and permanency to the track than where the foundation is the natural dirt, gravel, or clay.

"Wooden ties are reasonably plentiful and cheap in the United States, and are generally used instead of metal ties, which, however, have been recently adopted in Detroit, Terre Haute, and a few other cities, chiefly in the west. The ties are usually placed close together, rarely exceeding two-foot, or two and-a-half-foot centers. Creosote and other preservative compounds are rarely used, it being the general opinion that the life of the tie will be at least as long as that of the rail, but not of double length, so that, in relaying roadbed, it would not be advisable to put new rails on old ties, even if the latter were in fairly good condition. Gravel or broken stone is the usual ballasting material employed, the latter being more generally used in interurban lines and the former in the city streets, where the street foundations are well packed together and reasonably solid.

"The manufacture of girder rails for street railway purposes has become an enormous industry in the United States within the past six or seven years. It is estimated that the output of all our mills has, in the last ten years, amounted to nearly or quite 1,000,000 gross tons, and the present annual product is over 160,000 tons. Originally, there were several patented processes of making these rails, and the cost was placed considerably above the price of ordinary steel T rails, but within the last five years the price has dropped, until purchases can now be made at substantially T-rail prices."

Long-Distance Electric Transmission.

A GOOD example of one of the questions which may come up in any large electric road installation is treated in the *Street Railway Review* (Dec. 15). The editor introduces his comparison of central and auxiliary stations as follows:

"Now that transmission at pressures of 5,000 to 10,000 volts has become an assured electrical success, it is fitting for the electric railway engineer to inquire what bearing this new fact may have on his future work. It is not sufficient to the practical man to read of the possibility of transmitting large amounts of power long distances. He wants to know where and to what extent long-distance transmission at high pressures is commercially profitable.

"The only way to determine with accuracy as to whether centralized or subdivided power is the cheaper is to calculate

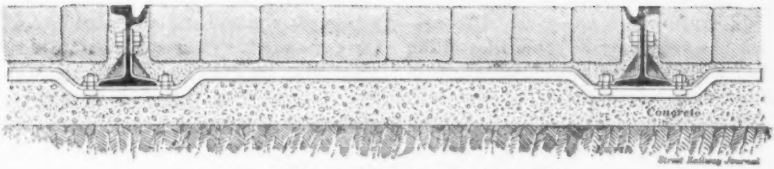


FIG. 2.—DETROIT ROADBED, WITH METAL TIES.

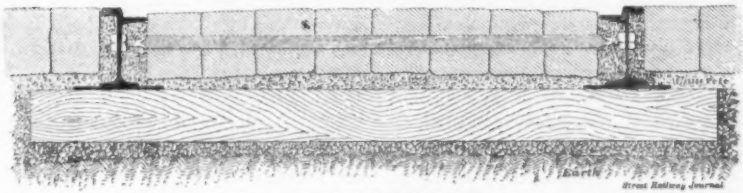


FIG. 3.—PHILADELPHIA ROADBED.

FIG. 4.—TORONTO ROADBED.

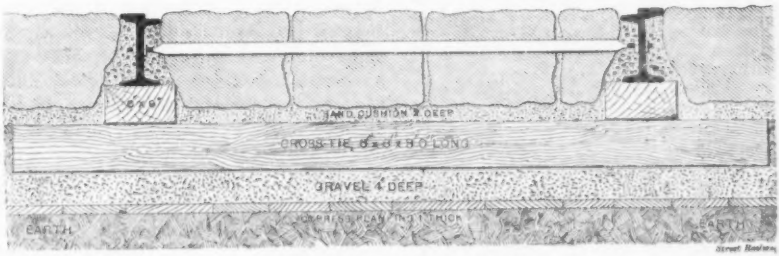


FIG. 5.—NEW ORLEANS ROADBED.

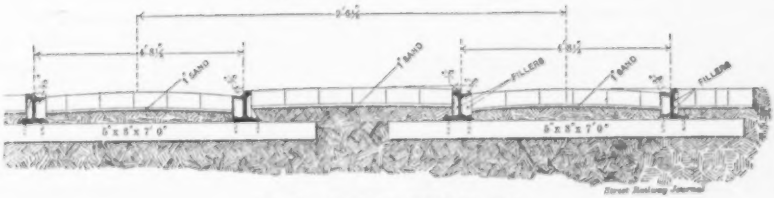


FIG. 6.—CHICAGO ROADBED, 1895

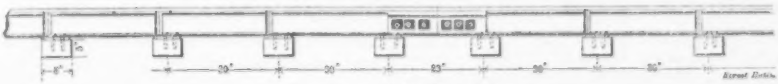


FIG. 7.—CHICAGO ROADBED.

every specific case. General rules can not be laid down which will cover all conditions. In order to give some idea of the commercial possibilities and limitations of high-pressure transmission, let us select a set of conditions which is likely to exist in the near future in several places. Assume that there is already in operation a large power plant supplying a city system, with machinery for the most economical production of power and with adequate provision for extension at a minimum expense. Assume now that fifteen miles away another division of road is to be built, which will require a maximum of 300 h. p. Will it be cheaper to build another power station to supply that division rather than transmit at high pressure from the big plant?"

To enlarge the central plant so as to be able to deliver 300 h. p. at the sub-station trolley bus will require a long-distance transmission under 5,000 volts pressure (allowing 10 per cent. loss), and a two phase circuit, as follows:

Steam plant at central station; 360 h. p.	$18,000
Generators at central station; 270 k. w.	5,400
Copper in lines	11,232
Step up transformers; $14 per k. w.	3,780
Step-down "	3,780
Rotary transformers; 224 k. w.	4,480
Sub-station building, etc.	1,000
Total	$47,672

The average losses in transmission will be about as follows: line, 5 per cent.; step-up transformers, 2 per cent.; step-down transformers, 2 per cent.; rotary transformers, 10 per cent.; total, 19 per cent. To deliver 150 horse-power average load to the trolley feeders at the sub-station with 19 per cent. loss requires 185 horse-power average at the central station. The fuel for the loss of 35 horse-power 20 hours a day will cost, under the foregoing conditions, $1,177 a year. The sub-station will require the services of two men, one for each watch. For comparison, then, the yearly operating expenses and fixed charges on the transmission system are as follows:

Interest on $47,672 at 6 per cent.	$2,860
Cost fuel lost in transmission	1,177
Two men at $60 per month	1,440
Total	$5,477

Suppose now a steam plant is to be erected at the sub-station location to do the same work. The small separate steam plant will cost more per horse-power than the addition to the large one. Assuming that it will cost $10 per horse-power more than a corresponding addition to the large steam plant, 300 horse-power at $60 per horse-power will amount to $18,000. Generators (224 kilowatts at $20 per kilowatt) will be $4,480. The cost of installing the separate plant is, therefore:

Steam plant	$18,000
Generators	4,480
Building, etc.	3,000
Total	$25,480

The yearly operating expense for comparison with such a plant is about as follows:

Interest on $25,480 at 6 per cent.	$1,528
Two men at $80 per month	1 920
Two men at $50 per month	1,200
Total	$4,648

Thus, under the above assumptions, the subdivided seems cheaper than centralized power generation. However, the matter will bear a little closer inspection. In making these calculations, it has been necessary to assume numerous conditions, and a change in one or two of these may throw the balance on the other side. Thus, if 10,000 volts were used instead of 5,000, there would be a reduction of three fourths in the amount of copper required, and the use of the three-phase system would reduce this still more, making a reduction of over $500 in fixed charges on the copper investment. Then, too, if coal was cheap, —say $1, instead of $2, per ton, as it is in many places,—the loss in transmission in this case would be reduced over $600 per year. This would make the centralized power production the cheapest.

"In spite of the modifications that the foregoing figures must undergo when applied to specific cases, it is evident that, unless changes are made from any existing railway transmission practice, conditions must be very favorable if a large interurban system can be operated cheaper by one large central steam plant transmitting power at high transformed voltages than by small steam plants in each district. In

any case the investment will be much greater for the transmission system than for the small stations." The hope for the future seems to lie in a successful alternating-current railway motor, with its high possible potential, absence of commutators and transformers, and great economy.

Illumination Tests.

IN order to determine the best light to be used in the Lehigh Valley Railroad coaches, Col. R. H. Wilbur, general superintendent of the road, caused a series of tests to be made by two experts, Professor W. H. Chandler and Professor J. E. Denton, of the best available lights. The results of these tests have been noticed in technical journals, and we deem them of sufficiently practical value to warrant us in quoting as follows from the original exhaustive and accurate report obtained through the courtesy of Professor Chandler:

"One of the 18.7 cu. ft. cylinders under chair-car No. 10 was charged with city gas at about seventeen atmospheres pressure, and another with Pintsch gas, under about eight and a half atmospheres, and tested during the nights of October 3 and 4." The lamps tested were of the Pintsch Argand and the Gordon-Mitchell Argand types, each used with both city gas and Pintsch gas alternately. The tests were made with the utmost care, the lamps being placed in the usual position in the car by representatives of the companies furnishing the lamps, who also acted as two of the four observers who made readings of the photometer in each test, the other two observers being Mr. Spanutius of Lehigh University, and either Prof. Denton or Prof. Jacobus of Stevens Institute." The disc of the photometer was about six inches square, hung in a hole in the heavy curtain screen by an axis permitting its surface to be presented directly to any of the lamps in front of it. Observations were made at four angles. The standard candles were calibrated by weighing and applying the appropriate corrections to the candle power obtained. Observations were taken with four lamps, and also with one lamp, burning.

"Our conclusions from the four-lamp data, with both lamps 40¾ inches above the centre of the photometer disc, are as follows:

"1. The Pintsch lamp with Pintsch gas averaged 1.583 times as much light as the G. M. lamp with Pintsch gas, and the latter consumed 1.003 times as much gas. Hence, for equal illumination, the G. M. lamp consumed 1.59 times the amount of gas required by the Pintsch lamp.

"2. The Pintsch burning Pintsch gas averaged, for the four angles, 1.76 times as much light as the same lamp with city gas, and the latter consumed 2.2 times as much gas. Hence, for equal illumination, the Pintsch lamp consumed 3.87 times as much city gas as it did of Pintsch gas.

"3. The Pintsch lamp with Pintsch gas averaged 1.555 times as much light as the G. M. lamp with city gas, and the latter consumed 2.21 times as much gas. Hence, for equal illumination, the G. M. lamp consumed 3.44 times the amount of gas required by the Pintsch lamp.

"4. The G. M. lamp with city gas averaged 1.13 times as much light as the Pintsch lamp with city gas, and consumed 1.006 times as much gas. Hence, for equal illumination, the Pintsch lamp consumed 1.11 times the amount of city gas required by the G. M. lamp."

The above "general illumination tests" were designed by Prof. Chandler and elaborated by himself and Prof. Denton. The following is the tabulated statement of tests with single lamps;

Lamp.	Kind of gas burned.	Average candle-power per cu. ft. of gas burned.	Relative amount of gas required per hour for equal illumination. Ratio.*	$\frac{1.00}{\text{Ratio.}^*}$ Gas consumed for equal illumination, as compared with the Pintsch lamp with Pintsch gas.
Pintsch lamp.	Pintsch	15.9	1.00	1.00
" " .	City	4.4	3.61	0.277
Gordon-Mitchell	City	3.6	4.42	0.226
	Pintsch	7.5	2.12	0.472

* Ratio = $\frac{\text{Candle-power of Pintsch burner with Pintsch gas} = 15.9}{\text{Candle-power of Pintsch burner with city gas and G. M. burner with both city and Pintsch gas.}}$

General Conclusions.—"The average of the results from both the single lamp tests, and the general illumination tests in which both lamps were at the same distance from the photometer, afford the following general conclusions:

"The useful illuminating power of the Pintsch Argand lamp in a car burning Delaware and Lackawanna Railroad Pintsch gas at the rate of 3.3 cu. ft. per hour is 3.73 times the amount which is afforded per cu. ft. by the same lamp burning compressed Jersey City water gas at the rate of 7.2 cu. ft. per hour; 1.71 times the amount afforded per cu. ft. by the Gordon-Mitchell lamp burning Pintsch gas at the rate of 3.3 cu. ft. per hour; and 3.92 times the amount afforded per cu. ft. by the Gordon-Mitchell lamp burning compressed Jersey City water gas at the rate of about 7.2 cu. ft. per hour."

The relative economy will be brought out in a later report; of course, this will depend largely upon the location and source of supply.

THE MAXIMUM FLEXION POINT IN AXLES was the title of a paper by Mr. Thomas Andrews, receiving the "Bessemer Premium" for 1895. *The Railway Review* (Feb. 15) abstracts the following: "Briefly, all the experiments coincided in indicating an increase of rigidity or brittleness of railway axles under the influence of the different kinds of stress and strain applied, the extent of the increase of rigidity being found to vary according to the nature of the metal, the condition of temperature and the species of the strain. The effects of stress were found to be similar, whether produced by slow flexion, impact shocks, torsional, tensile, or other strain. The result also showed that the greater the stress to which the metal was subjected the greater was the increase of rigidity and consequent deterioration of its physical properties. Steel axles, both Bessemer and Siemens, were shown to increase in rigidity and consequent deterioration under concussional shocks more than wrought iron ones. That railway axles at a temperature 100 degrees Centigrade, take a similar more extensive reduction of flexion endurance at 300 degrees Centigrade was a further important result of the research. This fact afforded a strong indication of the increased danger to railway axles arising from overheated railway axle journals or necks during running."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

3597. Some Pennsylvania Locomotives and Fast Runs (A detailed description with speed diagram and profile of road from Jersey City to Philadelphia. Average speed 57. 60 miles per hour. Full details are given of the locomotive performance). Ry Age-Jan. 10. 900 w.

†3603. The Railroad from Tien-Tsin to Shan-Hai Kuan (History of the beginning and progress of railroading in China, and of the road named in particular). Consular Reports-Jan. 2700 w.

3607. The Genesis and Progress of a Great Railroad System.—The Boston & Maine (The history of the route from the first stage route in colonial times to the present system. It is of considerable general interest). Ry Rev-Jan. 11. Serial. 1st part. 2800 w.

3608. Alignment Improvements on the Pennsylvania Railroad (A section of double track tunnel is given). Ry Rev-Jan. 11. 600 w.

3617. Increased Railway Earnings in 1895 (These statistics are given for each road and classes of roads for 1894 and 1895. It is a very detailed statement showing the increase in 1895 to be 5.2%). Bradstreet's-Jan. 11. 1400 w.

3619. The Street Railway Systems of Brooklyn (Illustrated description). Elec Ry Gaz-Jan. 4. Serial. 1st part. 1800 w.

3620. The Relation Between Stress and Sag in Span and Trolley Wires. E. A. Merrill (Special attention is called to points having particularly to do with the initial cost, especially in iron pole construction). Elec Ry Gaz-Jan. 4. 1700 w.

3621. A Glance at the Situation. Keppele Hall (Reviewing the various methods of street railway propulsion, and commenting on points for improvement, etc). Elec Ry Gaz-Jan. 4. 1700 w.

3622. A Decade of Progress (Electric traction in the last ten years). Elec Ry Gaz-Jan. 4. 800 w.

3623. Inspection of Electrical Rolling Stock. Charles F. Uebelacker (Criticising the number of methods, and making suggestions). Elec Ry Gaz-Jan. 4. 1200 w.

*3626. Brixton Cable Tramway (The largest cable road in Great Britain. The plant and

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equipment are fully described and illustrated). Ry Wld–Jan. 6. 400 w.

*3627. Composite-Corridor Carriages of the Great Western Railway (Cars containing separate compartments for first, second, and third class passengers and luggage-room in each carriage). Ry Wld–Jan. 250 w.

*3628. Locomotives for the Snowdon Rack Railway (A mountain locomotive, working on a gradient of 1 in 5½. It is of Swiss construction and has many interesting features). Ry Wld–Jan. 1200 w.

*3629. Light Railways: Their Construction and Working. William Rose Smith (This class of construction is well defined and its application in Mexico, Holland, Italy, Prussia, Belgium, Ireland and America described). Ry Wld–Jan. 4000 w.

3640. The High Speed Brake. R. A. Parke (From a paper read before the New England Railroad Club. Description of a quick acting brake used on the Empire State Express). R R Car Jour–Jan. 1000 w.

†3645. Emergencies in Railroad Work. L. F. Loree (A lecture delivered before the students of University of Wisconsin. Treating of wrecks, strikes, and organization). Bul of Univ of Wis–Dec. 11500 w.

3647. Repair of Electric Railway Apparatus. Ill. W. E. Shepard (This series of papers will give an outline of the various branches and departments connected with the operating side of electric street railway work. The aim will be to give some hints and suggestions in choosing, constructing and repairing railway apparatus and for guidance in the general routine of the maintenance department which may prove to be of assistance to the mechanic, foreman or superintendent having such work in hand). Elec Ind–Jan. Serial. 1st part. 1200 w.

3661. Air Brakes on Freight Cars (A discussion in the Western Railway Club of the paper by A. M. Waitt). R. R. Gaz–Jan. 17. Serial. 1st part. 3600 w.

†3665. Axles (A series of tests on railway axles, conducted at Sheffield, Eng., by the proprietor of the Worthy Iron Works). Ind & East Eng–Dec. 14. 2200 w.

*3715. Cost of Track Laying (Itemized estimated cost of six sections of road-bed and track for street railways. Each section is illustrated, and the article is valuable throughout). St Ry Rev–Jan. 15. 2500 w.

*3716. The Protection of Drawbridges (Suggestions as to methods designed to prevent street cars from running into open draws). St Ry Rev–Jan. 15. 1000 w.

*3719. Electric Railway Express. A. L. Stone (Illustrated description of equipment, showing how loaded wagons are carried on flat-top cars). St Ry Rev–Jan. 15. 700 w.

*3736. The Awakening of the Great Western (Some notes on the fast time made by the express trains on this road; average, 50 miles per hour. The time and distance table is given showing the average time between stations). Engng–Jan. 10. 1200 w.

*3753. Electric Power for Railroads. Harris J. Ryan (A review of the advance of electricity for railway purposes during the past year. In following numbers the writer will give a review of the engineering methods now in use for electric railroads and discuss those that will probably be given a trial in the near future). Sib Jour of Engng–Jan. 1300 w.

3766. The Electric Cable Railway of the Stanserhorn, in Switzerland (Illustrated description from *La Nature*). Sci Am Sup–Jan. 25. 2200 w.

†3774. Sleepers (Editorial discussion of the various types of railway ties and sleepers employed in India). Ind & East Eng–Dec. 21. 1400 w.

3775. Railroads in Massachusetts (The Annual Report of the Board of Railroad Commissioners. It is of considerable interest). R R Gaz–Jan. 24. 1500 w.

3776. Parlor Cars for an Electric Railroad (An up-to-date departure in Brooklyn, N. Y. The cars are finely upholstered, the details being represented in the accompanying illustrations). R R Gaz–Jan. 24. 400 w.

3777. Runaway Trains on Elevated Railroads (An editorial showing that such accidents are not due to any fault in design of the equipment). R R Gaz–Jan. 24. 2200 w.

3778. Preserving Timber with Woodiline (The method is described and advantages stated). R R Gaz–Jan 24. 1800 w.

3784. Revision of the M. C. B. Interchange Rules (The rules include specific instructions to inspectors, repair men, for billing cars and miscellaneous matters. It constitutes the report of the "Committee of Twenty-one" and is open to revision). Ry Rev–Jan. 18. 4000 w.

3785. An Air-Tight Dummy Coupling. Ill. (A compound air-brake coupling used on the Michigan Central R. R. possessing advantages that have led to their replacing angle cocks on engines). Ry Rev–Jan. 18. 600 w.

3786. The Cost of Railway Trains (The value of a regular train is about $50,000, and an ordinary passenger coach costs as much as a comfortable home, or half as much as a locomotive). Ry Rev–Jan. 18. 700 w.

3787. Oil Fuel for Locomotives—Los Angeles Terminal Railway (This description is interesting in view of the extreme saving effected over the cost by using California coal). Ry Rev–Jan. 18. 1000 w.

3800. The Transportation Problem in New York City (The editor thinks the present transportation systems overcrowded, but says the free spirit of Americans will rebel at any underground transportation scheme, and further that easy transportation induces increased traffic). Sci Am–Jan. 25. 1600 w.

*3829. Steam Locomotives on Common Roads. W. Fletcher (Description of various designs and uses to which they are put). Eng, Lond–Jan. 17. Serial. 1st part. 3300 w.

3838. The Hauling Capacity of Locomotives. H. H. Vaughan (Abstract from a paper read before the Northwestern Railway Club. A

valuable article, both practical and theoretical). Ry Rev-Jan. 25. 2700 w.

3839. Air Brake Equipment on Freight Trains (Discussion upon paper on same subject, an abstract of which was published in this journal on Dec 14. It deals with the trouble some roads have had with the freight air brake). Ry Rev-Jan 25. 1800 w.

3848. The Fastest Railroad Run Ever Made. Ill Harry Perry Robinson (Distance 510 miles —average running time 65.07 miles an hour—highest speed attained 92.3 miles an hour). McClure's Mag-Feb. 5500 w.

*3851. The Dublin-Dalkey Electric Tramway. Ill. (One of the most interesting features of this system consists in the adoption of power transmission by means of polyphase currents, between the power house and the two sub-stations which feed the line en route. Descriptive). Elect'n-Jan. 17. 2500 w.

*3854 The Coventry Electric Tramway System (Illustrated description). Elec Rev, Lond-Jan. 17. 2800 w.

3867. Some Information from Indicator Cards. D. (A series of six cards is given which were taken from locomotives, and they illustrate the work in the cylinder very clearly under different conditions). R R Gaz-Jan. 31. 1200 w.

3868. A Costly Track for Hard Service (The elaborate equipment at the Grand Central terminal is described, with special reference to steel ties and rail fastenings). R R Gaz-Jan. 31. 1400 w.

†3894 Indian Railway Provident Institutions (Discussion of the system which insures a railway employee a competence upon being retired from service). Ind Engng-Dec. 28. 1500 w.

*3895. Cercovado Railway, Brazil. Lewis Gleason (A well illustrated description of a rack railway up the side of Mt. Cercovado, which overlooks Rio de Janeiro. The engine is of Swiss manufacture and the grade from 16 to 25 per cent). Loc Engng-Feb. 1000 w.

*3900. Agreements, Contracts, Specifications, Installation and Repairs. W. H. Elliott (The author shows exactly what should be included under the given headings in the installation and operation of a signal system. Crossings, signal-towers and interlocking are given special attention). Loc Engng-Feb. 5000 w.

†3916. The Mt. Snaefel Railway, Isle of Man (A well illustrated description. A third rail in the center line of the track prevents derailment and in cases of emergency is clutched by a grip brake). St Ry Jour-Feb. 400 w.

†3917. Conduit Electric Railways. A. N. Connett (Notes on the operation of the Ninth Street Line of the Metropolitan Railroad Co., Washington, D. C. The operating expense per train (motor car and trailer) mile was about 8 87 cents). St. Ry Jour-Feb. 1700 w.

†3918 Power Distribution for Electric Railroads. Louis Bell (A thoroughly technical article, illustrated by diagrams). St. Ry Jour-Feb. 4000 w.

†3919. Truck and Motor Repairs (An itemized statement showing that the repairs of gear wheels are 56% of the total number of repairs with a cost of 59% of the total cost of repairs). St Ry Jour-Feb. 600 w.

†3920. Electric Street Railway Tracks. R. J. McCarty (Three methods of laying ties on broken stone mixed with sand. The one proposed will cost $1736 per mile of single track road-bed). St Ry Jour-Feb. 1300 w.

†3921. The Doom of the Cable in San Francisco. S. L. Foster (Illustrated description of method used to convert over half a mile of cable road into a trolley line of wider gauge, in seven days). St Ry Jour-Feb. 1500 w.

†3922. Club House for Motormen and Conductors (The street railway at Derby, Conn., has converted one of its buildings into a club house containing bath, dining-room, reading-room, pool and billiard room and gymnasium. The scheme proposes to bring the employees into closer relation to the company). St Ry Jour-Feb. 700 w.

*3938. Notes on Russian Engineering. Charles Hyde (Abstract of a paper read before the Engs. Soc. of W Penna. The points touched are both detailed and interesting). Am Eng & R R Jour-Feb. 3700 w.

*3945. Old Great Southern and Western Railway Locomotives (Eighteen diagram illustrations of some peculiar types with plans and sections of firebox). Eng, Lond-Jan. 24 300 w.

†3967. Discussion of Air Brake Equipment (Discussion by the members, of a paper read by Mr. Waitt. The opinions expressed are valuable, as they come from those engaged in practical railroad operations). Pro West Ry Club-Dec. 15500 w.

†3968. Locomotive Service. J. H. M'Connell (An interesting paper on the growth, economy in operating, hauling capacity, and work of locomotives. The author thinks the engines should be loaded more heavily). Pro W Ry Club-Dec. 2000 w.

4024. Statutory Regulation of Interlocking Signals for Railway Grade Crossings (Historical summary of the statutory regulation of grade crossings in Illinois from the various reports of the Railroad and Warehouse Commission of the State, and from the report of the present consulting engineer, Mr. Dwight C. Morgan, for the year 1895). Eng News-Feb. 6. 2800 w.

4028. Some Railroad Matters in England. W. M. Acworth (Communication on light railways, rates on farm products, and other items of interest). R R Gaz-Feb. 7. 2300 w.

4032. Recent Improvements in Design and Construction of Locomotives (The latest practice in boiler construction is given special attention). R R Gaz-Feb. 7. Serial. 1st part. 2000 w.

4052. Some Interesting Facts Relative to the Double Trolley System. Bert L. Baldwin, with editorial (The successful working of this system in Cincinnati, with the advantages, and objections are considered. The development of the s tem, with many illustrations). Elec-Feb 5. 2500 w.

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

The X Rays—Professor Röntgen's Discovery.

RECENT scientific developments almost incline thoughtful people who have followed them to believe that we are on the eve of very remarkable revelations. It is certain that a multitude of mysteries yet remain unpenetrated, and each new discovery becomes a powerful engine wherewith to delve further into mines that seem richer as men of science penetrate deeper into them. We now stand in possession of many secrets the discovery of which would have appalled investigators in the middle ages, and which they would not have dared even to hint, much less widely promulgate. Professor Röntgen, had he lived then, would probably have been burned at the stake as a sorcerer and a heretic. To what extent his recent discovery will reach in its effects upon scientific progress and upon industrial methods cannot yet be predicted, but some of the effects which seem obvious even at this early stage are noted in *The Engineering and Mining Journal* (Feb. 1). Another article by Hugo Münsterberg, of Harvard University, and an editorial note, both in *Science* (Jan. 31), define the present scientific status of the discovery and its probable practical importance. *Science* says, editorially:

"The transmission through wood and other substances of the rays from a Crookes vacuum tube, discovered by Professor Röntgen, is reported to have been confirmed by Professor Klupathy of Pesth, Prof. Domalip of Prague, Prof. Czermak of Gratz, and Mr. A. A. C. Swinton of London. The photographs have been exhibited before several scientific societies, and, by Prof. Röntgen, to the emperor of Germany, from whom he has received a decoration.

"Mr. Swinton writes to the *Standard* that, with Mr. J. C. M. Stanton, he has obtained distinct proof that the radiations in question do pass easily through various substances that are quite opaque to ordinary light, and do produce strong impressions upon ordinary photographic plates entirely encased in light-proof material. Indeed, all substances that he has so far experimented on in his laboratory appear to be transparent to these radiations, even sheets of ebonite, carbon, vulcanized fiber, copper, aluminum, and iron, though there is considerable variation in degree. It is thought that the new method of photography may have important applications, not only in surgery, but also in metallurgy, by revealing flaws, inequalities, and fractures in metals.

"Hertz discovered that cathode rays pass through metal films not translucent to ordinary light, and Dr. Lenard and others have published careful experiments on the subject. Attention has been called to Prof. Zeugen's having photographed Mt. Blanc, in 1885, by the cathode rays. Professor Röntgen, however, states that the rays discovered by him, which he calls X-rays, are not cathode rays, as they are not refrangible nor affected by magnetic influences, but that they are most probably longitudinal waves in the ether.

"While Hertz and Lenard hold that the cathode rays are vibrations in the ether or even light of short wave-length, Crookes and J. J. Thomson have urged that the rays are negatively-charged matter traveling with great velocity. M. Perrin reported to the Paris Academy, on December 30, experiments which tend to show that the latter view is correct, and some relation will probably be found between cathode rays and the X-rays."

Mr. Münsterberg thinks "it may be that the practical importance of the discovery is equal to the theoretical. It is well known throughout the world that the physical laboratories of Germany have no windows looking towards the patent office. The hunting for practical inventions is not usually important for theoretical science, but the progress of theory usually has

practical applications. One practical result in this case is already clear; as the new rays pass boards, but not thick metal plates, so they pass the organic substances of the human body, such as skin, muscles, etc., but not the bones. As the metal weights in the wooden box can be photographed, so can photographs of the human bones be taken. Röntgen has put his hand between the tube and the dry plate in the closed camera; the photograph shows clearly all the bones of the hand without the flesh and skin, and the gold rings seem to hang in the air. The value of such a method for medical diagnosis is clear. Fractures and diseases of bones can be examined by photographic plates, and metal pieces in the body—for example, needles, bullets, etc.,—can be found by this method. It will be a matter of the future to learn whether the rays have psycho-physiological effects.

"The newspapers report that the whole thing was discovered by mere chance. Röntgen saw the effects on photographic papers, which by chance were near to a covered tube during the discharge. This chance origin is not probable, as Lenard, the assistant of Hertz, has been working in the same direction for a long time, and many preparatory experiments by Röntgen himself cleared slowly the way. But suppose chance helped. There were many galvanic effects in the world before Galvani saw by chance the contraction of a frog's leg on an iron gate. The world is always full of such chances, and only the Galvanis and Röntgens are few."

A Brooklyn physician suggests to us that certain diseases—osteosarcom, for example—may be found to so modify organic tissues normally permitting the free passage of the X-rays as to render them more or less opaque to these rays, and thus permit the boundaries and extent of the diseases to be mapped out, and their progress to be traced.

In the mechanic arts the discovery promises to be immediately fruitful. The article in *The Engineering and Mining Journal* contains important facts upon the behavior of the X-rays with the metals. Among these it is mentioned that aluminum and lead are translucent to the new rays, and that no two metals are alike in this respect. It says:

"Lead proves to be almost as translucent as aluminum or wood. Hitherto it has not been possible without a complicated process to test the uniformity of structure of metal work,—for instance, gun-barrels, iron rails, railroad wheels, etc., or to distinguish at sight the different varieties of iron and steel. All this, it is anticipated, will be shortly achievable by the help of the new photography. It is no exaggeration to say that this would mean the complete revolution of many branches of metallic industry, especially the manufacture of arms."

No more pronounced instance of the possibilities that lie in the discovery of any new physical fact can be found than in the history of this discovery and those which led up to it. This history might begin with Geissler's tubes. The next great step was made by Professor Crookes, who so far improved upon Geissler's methods as to attenuate matter in hermetically-sealed glass bulbs almost to the vanishing point. A series of astonishing results, previously unknown to the scientific world, soon followed, and the fame of the experimenter, already great through previous researches, rose to the highest point. Röntgen has now discovered what eluded even Professor Crookes. When the latter made public the results obtained by vacuum tubes, they appeared like a species of magic, so far removed from any industrial application (with perhaps the exception of the radiometer, subsequently proved to be misnamed) that "*Cui bono?*" was frequently reiterated by the sceptical, yet interested, public. This question is now about to receive its answer, and in a much shorter period than was then anticipated.

If our memory serves us, it is not much more than twenty-five years since Professor Crookes made known his modifications of the Geissler tubes. Instead of tubes, proper, he made use of egg-shaped glass bulbs, in which, by refined methods, he produced vacua much greater than had been gained by any previous experimenter.

A positive electric current is brought into the tube by a platinum wire fused into the glass (the anode); and at another point is placed another similar arrangement by which the current passes out—the cathode. When an electric current passes through such a bulb, the interior becomes luminous, and certain special properties of the light-rays, which we will not here discuss, led to the use of the terms "anode-rays" and "cathode rays," as distinguishing the character of the light at the respective platinum terminals.

Many who have written about Professor Röntgen's discovery have called the light by which he has obtained his remarkable results "*cathode* rays," but he, himself, asserts that the light differs in important respects from the cathode rays, and states the differences. He gives to the newly-discovered light the name "X rays."

The Lowest Temperature Yet Reached.

ACCORDING to the *Journal of Gas Lighting* the lowest temperature yet artificially produced has been obtained by Professor Olszewski, who has "recently determined the boiling point and the critical temperature of hydrogen; and the result shows that it is possible, by taking proper precautions, to do experimental work in the domain of physics at a point very near the absolute zero of temperature. The process is described in detail in *Wiedemann's Annalen*. The method of expansion, which had already been successfully employed to ascertain the critical pressure, was again utilized. The critical temperature being that at which liquid hydrogen, when slowly released from pressure, first boils up; and the boiling point is the temperature reached when the pressure is reduced to that of one atmosphere. The chief difficulty in these experiments is the thermometric one; and Professor Olszewski successfully overcame this by the employment of a thin platinum wire immersed in the liquid hydrogen, which, by its varying resistance, indicated the fall of the temperature. It is interesting to note, in connection with what has been stated with regard to the effect of cold upon the strength of materials, that Professor Olszewski used cast-iron cylinders brought down to a temperature of 210° C. (not far from absolute zero) by means of liquid oxygen, at which the cylinders still held oxygen compressed to 180 atmospheres. The critical temperature of the hydrogen was, however, still lower, and was not reached until 234.5°C. had been registered. The boiling point was 243.5°C., or 406.3°F. (probably the greatest cold ever attained by artificial means).

Expired Air and Problems of Ventilation.

UNDER this title in *Popular Science Monthly* are given the conclusions of three prominent men in the scientific world, which so conflict with previous views entertained by other students of ventilation, and even those formerly entertained by at least one of these gentlemen, that they at once challenge attention. The accuracy of the conclusions is likely to be questioned.

The gentlemen referred to are Dr. J. S. Billings (a well-known author of works upon heating and ventilation), Dr. S. Weir Mitchell, and Dr. D. H. Bergey. The conclusions—an abstract of which from the article above named follows—have been published in the Smithsonian contributions. We do not know that any of these gentlemen has ever expressed publicly any other view of the quality of expired air than those contained in this abstract, except Dr. Billings. He, at least, is on record as holding the opinion that carbonic acid, present in the atmosphere of an inclosed space, and produced by the respiration of warm-blooded animals, is a reliable indication of other and more poisonous exhalations, which, though they are not directly measurable,—or, at least, are very difficult to measure directly,—bear a practically constant relation to the amount of carbonic acid exhaled. This has been the generally-accepted view, and we confess that the experiments from which the contrary is inferred do not yet convince us of its fallacy. Certainly it has been found that an amount of carbonic acid generated from marble and sulphuric acid can be endured with impunity, which, if generated by respiration, would be accompanied by great discomfort.

In this new gospel of ventilation it is declared that there "is no peculiar organic matter which is poisonous to animals (excluding man) in the air expired by healthy mice, sparrows, rabbits, guinea-pigs, or men. The injurious effects of such air appeared to be due entirely to the diminution of oxygen or the increase of carbonic acid, or to a combination of these two factors. It is very improbable that the minute quantity of organic matter contained in the air expired from human lungs has any deleterious influence upon men who inhale it in ordinary rooms. In ordinary quiet respiration no bacteria are contained in the expired air. In the act of coughing or sneezing such organisms may be thrown out. The minute quantity of ammonia, or of combined nitrogen, or other oxidizable matters found in the condensed moisture of human breath appears to be largely due to products of the decomposition of organic matter which is constantly going on in the mouth and pharynx. The air in an inhabited room, such as a hospital ward, in which experiments were made, is contaminated from many sources besides the expired air of the occupants, and the most important of these contaminations are in the form of minute particles or dusts. The experiments on the air of the hospital ward showed that in this dust there were micro-organisms, including some of the bacteria which produce inflammation and suppuration, and it is probable that these were the only really dangerous elements in this air. The results of experiments, in which animals were compelled to breathe air vitiated by the products of either their own respiration or by those of other animals, make it improbable that there is any peculiar volatile poisonous matter in the air expired by healthy men and animals other than carbonic acid."

Again it is said: "The proportion of carbonic acid and of diminution of oxygen which has been found to exist in badly-ventilated churches, schools, theaters, or barracks is not sufficiently great to account for the discomfort which such conditions produce in many persons, and there is no evidence to show that such an amount of change in the normal proportion of these gases has any influence upon the increase of death-rates which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. It has been well established by observation and statistics that tuberculosis and pneumonia are the diseases most prevalent among persons living and working in unventilated rooms. But consumption and pneumonia are caused by specific bacteria, which, for the most part, gain access to the air passages by adhering to particles of dust which are inhaled; and it is probable that the greater liability to these diseases of persons living in crowded and unventilated rooms is to a large extent due to the special liability of such rooms to become infected with germs of these diseases."

"The discomfort produced by crowded, ill-ventilated rooms in persons not accustomed to them is not due to the excess of carbonic acid, nor to bacteria, nor in most cases to dusts of any kind. The two great causes of such discomfort, though not the only ones, are excessive temperatures and unpleasant odors. The cause of the unpleasant musty odor which is perceptible to most persons on passing from the outer air into a crowded, unventilated room is unknown; it may, in part, be due to volatile products of decomposition contained in the expired air of persons having decayed teeth, foul mouths, or certain disorders of the digestive apparatus, and it is due in part to volatile fatty acids given off with, or produced from, excretions of the skin. The results of this investigation, taken in connection with the results of other recent researches, indicate that some of the theories upon which modern systems of ventilation are based are either without foundation or doubtful, and that the problem of securing comfort and health in inhabited rooms requires the consideration of the best method of preventing or disposing of dusts of various kinds, of properly regulating temperature and moisture, and of preventing the entrance of poisonous gases, like carbonic oxid, derived from heating and lighting apparatus, rather than upon simply diluting

the air to a certain standard of proporiton of carbonic acid present."

Nevertheless, these investigators say that "it would be unwise" to depart from the standard of air-supply "based on the results of Pettenkofer's work." No reason why this would be unwise is given. If the theory hitherto held be all wrong, why should we adhere to a practice that has this theory for its only sanction?

The cause for the bad odor in all ventilated rooms is stated to be unknown. If so unknown, how is it known that the material which constitutes the odor is not injurious to health, or that it does not cause discomfort other than its offensiveness to the olfactory apparatus? These views, coming from such a source, are likely to give rise to an interesting debate.

Floating Sand.

BODIES of great specific gravity, when divided to such minuteness that a sufficiently large surface in proportion to the weight of the particles is secured, will float on water, the cohesion of the liquid surface sufficing to sustain these small weights without breaking under them. Thus gold precipitated from a solution of its terchlorid by methylic alcohol will float; or fragments of finely-beaten gold leaf will float indefinitely on the surface of pure distilled water. But particles of this sort are very much smaller than any kind of native sand, and something further is necessary to explain the phenomenon of sand floating on the surface of streams of water, described by Mr. Frederic W. Simonds in the *American Geologist* for January. The author of this interesting account says he observed this singular phenomenon during his stay with a camping party on the banks of the Llano river, a clear stream, tributary to the Colorado, flowing through what has been termed "the central mineral region." The sand formed from the disintegration of the rocks in this locality is "granite sand," though composed of vitreous and pink quartz with some other minor ingredients.

"The morning after my arrival, the river was found to be rising, and, as I stood on the bank, at the point where we secured our water supply, I noticed a considerable froth and what appeared to me, at the time, scum passing down the stream. I spoke of the condition of the river to my companion, Mr. Laurence D. Brooks, of Austin, who remarked that what seemed to be scum was really sand. I thereupon went down to the water's edge, and, dipping up some of the floating material, was astonished to find that the patches were composed of sand, mainly of quartz. At this time—half-past nine or ten—the water supported a large number of patches, which varied in area from less than a square inch up to several square inches, all swept along by the current.

"The phenomenon was witnessed only while the river was rising When the water began to recede, no more floating sand was seen. The reason for this will appear later.

"Noting my surprise, Mr. Brooks stated that he had seen sand floating on some of the streams of Alabama, and that it had oftentimes been very troublesome in digging water-holes. To test this statement I at once scooped out some holes in the damp sand, and, surely enough, as their sides caved in, a few grains floated away on the surface of the water which immediately filled the holes. Between the grains there seemed to exist a mutual attraction, in consequence of which they ultimately grouped themselves into small patches similar to the smaller patches seen on the river. In the meantime, Mr. Brooks, by gently sifting dry sand from his hands onto the water, succeeded in forming much larger patches.

"A week later, when the river was well down and the sandy stretches of its bed had become quite dry on their surface, I gathered sand by handfuls, and sent it floating down the stream in such quantities that the sand-rafts actually cast shadows on the bottom as they passed. Then I dug several large holes, as I had previously done in the damp sand, but with far better results, for, when their sides caved in, the dry grains forming the outer coat of the deposit were gently launched, and floated off much more abundantly. Futhermore, as each mass

of sand slipped into the water and, exclusive of the floating grains, sank, the air contained in the interstices between the particles rose to the surface, forming a patch of foam or froth. The observations here made strong proof of the probable explanation of the phenomenon of floating sand from a geological standpoint, the physical explanation being quite a different matter."

The patches of floating sand observed on the Llano river are accounted for by the crumbling of its sandy banks whenever the water rises.

The same phenomenon was observed by Mr. James C. Graham on the Connecticut river in 1890, and reported in the December number of the *American Journal of Science* for that year. He accounted for it by the action of capillarity.

Experimenting with sand of quartz and other minerals, Mr. Simonds has since found that a considerable variety of sand will float, and he gives a tabulated statement of sands obtained from different localities,--their origin, composition, size and shape of grains, and behavior when gently thrown upon the surface of water. Out of fourteen different specimens thirteen float more or less markedly.

Mr. Simonds repeated his experiment with rain water, distilled water, Colorado river water, and river water boiled and filtered, and found no appreciable variation in their action. The attraction for each other of the undivided floating grains, which tends to aggregate them into floating patches, is one of the remarkable features of the phenomenon. Though scattered over a surface a foot in diameter, they ultimately formed a single raft.

Mr. Simonds gives, tentatively, his own explanation of the phenomenon as follows:

"When shaded, it will be seen that the floating sand grains cause a depression of the water's surface, which indeed is quite as apparent in the case of isolated grains as in that of patches. I recall one instance where the depression, of very short duration, possibly but a few seconds, was so great as to be positively startling. As I was sprinkling some sand upon the river, for experimental purposes, a pebble almost as large as the end of my little finger fell into the center of a floating patch, which, to my great astonishment and delight, was depressed like a funnel for, say, half an inch, before the cause of this unexpected phenomenon broke through the surface and sank to the bottom.

"It appears from these and other observations that the weight of the sand grains actually depresses the surface of the water; yet the elastic reaction of that surface is sufficiently great to prevent them from sinking, especially when the resistance offered by their angularity is taken into consideration. In the launching of grains the more rounded would tend to roll over in the water and thus become wet, in consequence of which they would sink, while those of an irregular shape would overcome the tendency to roll and remain partially dry, thus fulfilling a condition necessary for floating."

This is a good account of careful observations of a very interesting phenomenon that has hitherto attracted little attention, and which may have an important relation to the formation of channels and banks in rivers. Further study, however, may evolve a different theory of its cause; that above given does not seem entirely adequate.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

3573. Advice to Young Men Who Wish to Become Successful Engineers. W. H. Wakeman (Relates to education in schools and works). Lord's Mag-Jan. 2200 w.

*3591. The Bradford Technical College (Interesting description of a now famous English school). Engng-Jan. 3. Serial. 1st part. 1800 w.

*3625. Engineering Progress (One of the most comprehensive general reviews of progress in different branches of engineering, and in the industrial world, that has yet appeared). Eng. Lond-Jan. 3. 25000 w.

*3686. The French Universal Exposition of 1900. Count Alphonse de Calonne (An account principally of the difficulty in securing a suitable site, followed by a description of the locality decided upon, and the location of the exhibits). Arch Rec-Jan-March. 4000 w.

We supply copies of these articles. See introductory.

†3721. On the Photometry of Differently Colored Lights and the "Flicker" Photometer. Frank P. Whitman (Exceedingly interesting account of the development of a new photometric instrument and method, based on Prof. Rood's "flicker principle." Diagram representations of the new apparatus and curves of the relative luminosities of nineteen different colors are presented, as illuminated by a kerosene lamp, a grey sky, and a bright blue sky). Phys Rev-Jan-Feb. 2800 w.

†3723. On the Freezing-Points of Dilute Aqueous Solutions. E. H. Loomis (Describes the continuation of an elaborate series of experiments, with a tabulated presentation of the constants determined). Phys Rev-Jan-Feb. 6000 w.

3768. Prof. Roentgen's Alleged Discovery (Editorial on the claim that it is possible to photograph objects behind opaque substances. A review of what is reported as having been accomplished with comments). Elec-Jan. 22. 1800 w.

3783.—75 cts. Pyrometry: Calibration of the Le Chatelier Thermo-Electric Pyrometer. S. W. Holman (The usual method is described and a new and simplified method explained). Tech Quar-Oct. 4000 w.

*3799. On Flame Temperatures and the Acetylene Theory of Luminous Hydrocarbon Flames. Arthur Smithells (A paper read before the Chem. Soc. Topics discussed are the temperature gradients of flame; non-luminous hydrocarbon flames; luminous coal-gas flames; occurrence of acetylene in flames; comparison of different flames; the flames of acetylene; thermo-chemical considerations, and the alleged liberation of carbon from cyanogen in flames. The arguments of Prof. Lewes in support of the last named proposition are asserted to be invalid and an attempt is made to prove them so). Jour Gas Lght-Jan. 14. 5500 w.

*3819. The Metric System and Standard Screw Threads (Editorial discussion of a recommendation recently made by a committee of the House of Commons, that a law be passed making the adoption of the metric system in England compulsory within two years from its enactment. The benefits of the metric system are admitted, but the difficulties to be met in making such a change are formidable). Engng-Jan. 17. 2800 w.

3834. Chief Swenie on Fire-Fighting (First part deals with the increased and still increasing fire hazards, much of which increase is due to methods of heating and lighting unknown to previous generations, and also to new industries and modern methods of organizing industrial establishments, and current methods of constructing industrial buildings). Fire & Water-Jan. 25. Serial. 1st part. 2000 w.

3881. Dark Light Photography. C. J. Reed (An article on the alleged results of Prof. Röntgen in photographing without light). Elec Wld-Feb. 1. 1000 w.

†3887. Gathering Naval Stores. Lee J. Vance (The turpentine industry in the United States and its methods contrasted with French methods, the latter being considered much superior). Pop Sci M-Feb. 3800 w.

3902. The X-Rays. Hugo Münsterberg (A review of Prof. Röntgen's discovery, and an editorial note which shows that others have been at least on the threshold of the same discovery for some time. List of scientists in the United States and Europe who have repeated Prof. Röntgen's experiments with confirmatory results). Sci-Jan. 31. 1800 w.

3903. Roentgen's Discovery (Discusses the discovery by Prof. Roentger of a kind of light which passes through bodies hitherto classed as opaque, and suggests some practical applications of the discovery in the arts). Eng & Min Jour-Feb. 1. 2500 w.

3909. Prof. Roentgen's Light (Comments by Prof. Edwin H. Hall, of Harvard College, upon the new discovery. Reprinted from the *N. Y. Sun*). Am Gas Lgt Jour-Feb. 3. 1500 w.

†3914. The Newest Telescope. C. A. Young (The Yerkes Telescope. The difficulties in obtaining achromatism in the object glasses of large refracting telescope are explained, and reference is made to the German experiments now in progress, and directed to securing this quality in a higher degree. A detailed description of this great instrument, and of the observatory in which it is placed is very interesting and shows in some degree, how even astronomical progress is linked with the mechanical and engineering progress of the age). N Amer Rev-Feb. 3800 w.

†3923. Researches in Acoustics. Alfred M. Mayer (Containing the variation of the modulus of elasticity with change of temperature as determined by the transverse vibration of bars at various temperatures. The acoustical properties of aluminum). Am Jour of Sci-Feb. 5000 w.

†3924. The Counter-twisted Curl Aneroid. Carl Barus (Account of an experimental research to determine effects of modifications of the Bourdon tube). Am Jour of Sci-Feb. 4500 w.

*3932. On Röntgen's Rays (Correspondence with *Nature* upon the new discovery by Alfred Schuster and J. T. Bottomley). Nature-Jan. 23. 1800 w.

*3933. On a New Kind of Rays W. C. Röntgen (In this paper the discoverer of the X-rays states their properties and gives definite information by which his experiments may be repeated). Nature-Jan. 23. 2800 w.

*3934. Professor Röntgen's Discovery. A. A. C. Swinton (The writer describes experiments confirmatory of Röntgen's discovery. He obtains better results with high frequency currents than with even a large sized Rhumkorff coil). Nature-Jan. 23. 800 w.

*3947. A New Integrator. A. Russell and H. H. P. Powles (Description of a cheap appliance to be used with an Amsler's planimeter for performing integration) Eng, Lond-Jan. 24. 1000 w.

*3961. Photographing the Unseen; or, the New Electro-Photography (Review of the discovery of Prof. Röntgen, with illustrations showing the results of his work). Elec Rev, Lond-Jan. 24. 1000 w.

*3962. Absorption of Cathode Rays. P. Lenard (Experiments in proof of assumptions

made). Elec Rev, Lond–Jan. 24. Serial. 1st part. 1800 w.

*3966. On a New Form of Radiation. Wilhelm Konrad Röntgen (Preliminary communication to the Würzburg Physico-Medical Society). Elect'n–Jan. 24. 3500 w.

3978. Cathodographs by Prof. Wright, of Yale University (Illustrated account of experiments which were suggested by Prof. Röntgen's late discovery). Elec Eng–Feb. 5. 800 w.

3979. The Phenomena of the Cathode Rays. —Suggested Apparatus for their Production. Elihu Thompson (Suggests a novel method of constructing a cathode ray generator). Elec Eng–Feb. 5. 700 w.

3980. Photographs Taken by the Moore "Etheric" Light. Ill. (Results obtained by the employment of the direct lighting effects of vacuum tubes in the photography of objects in the usual manner). Elec Eng–Feb. 5. 600 w.

3982. The Roentgen Ray Photography. Edwin H. Hall (From the *N. Y. Sun*. A review of investigations that led up to the recent discovery by Roentgen). Elec Eng–Feb. 1. 1500 w.

3983. Photography of the Invisible Without the Aid of a Crookes' Tube. Ill. William James Morton (Results attained by the writer, showing that effects similar to those attained by Crookes' tubes, are not impossible without the employment of highly vacuous enclosures). Elec Eng–Feb. 5. 800 w.

3992 The Burning of Clays. Thomas Townsley (A practical discussion of means and methods of baking bricks, pottery, &c). Brick–Feb. 4000 w.

4002. Röntgen's Photographs. A. E. Dolbear (An article calling attention to the fact that this discovery had been predicated). Elec Wld–Feb. 8. 600 w.

4003. The New Photography (A résumé of matter thus far printed concerning the discovery. Also editorial). Elec Wld–Feb. 8. 3700 w.

4041. The Internal Temperature of Rocks (Temperatures at different depths in the shafts of the Hecla and Calumet Mining Co). Eng & Min Jour–Feb. 8. 400 w.

4044. James Dwight Dana. J. W. Powell (The contributions to knowledge due to the life work of this eminent scientist. Great as a zoölogist, greater as a mineralogist, but greatest as a geologist). Science–Feb. 7. 2200 w.

4045. Pasteur. George M. Sternberg (An able discourse on the life and achievements of Louis Pasteur, born at Dôle in the Department of Jura, France, Dec 27, 1822; died at Garches, a suburb of Paris, Sept. 28, 1895). Science–Feb. 7. 2500 w.

4046. Helmholtz. T. C. Mendenhall (Account of his life and scientific labors. An interesting account of the rise and final triumph of the doctrine of the interconvertibility of forces is comprised in this article). Science–Feb. 7. 3900 w.

4048. Water Supply of Niagara. Orrin E. Dunlap (Considering the danger of drawing off so much water for power purposes as to ruin the beauty of the cataract). W Elec–Feb. 8. 1200 w.

4051. Roentgen Rays. M. I. Pupin (Reviewing the former experiments on electric discharges through rarefied gases, and asserting the importance of Roentgen's discovery). Elec–Feb. 5. 1300 w.

†4056. The Use of Pure Gum Bandages in Surgery. Henry A. Martin (The advantages of such bandages are explained, and cases where they are specially helpful are cited). Ind Rub Wld–Feb. 10. 3500 w.

†4059. India Rubber Statistics for 1895 (Interesting as showing the increase in the rubber industry both in this country and England). Ind Rub Wld–Feb. 10. 500 w.

†4060. India-Rubber Cement. George B. Scott (The uses of this cement and its promising future). Ind Rub Wld–Feb. 10. 700 w.

†4061. The Harmless Cheapening of Rubber Goods. Edward F. Bragg (Advocates the cheapening of production through improved processes, or machinery). Ind Rub Wld–Feb. 10. 800 w.

4063. The Invention Epoch in the Cotton Trade. Joseph Nasmith (An interesting address, upon some world famous inventions, delivered before the Manchester Asso. of Engs). Bos Jour of Com–Feb. 8. Serial. 1st part. 1800 w.

†4067. Lacroix' Axial Goniometer. N. H. Winchell (Illustrated description of an attachment to the microscope, with solution of an example for measuring the optic angle of minerals.) Am Geol–Feb. 600 w.

†4068. A Study of Some Gas-Producing Bacteria. A. A. Bennett and E. E. Pammel (Chemistry of gaseous bacterial products and excretions, together with a bibliography of the literature upon this subject). Jour of Am Chem Soc–Feb. 2400 w.

†4071. Note on the Use of Acetyline Gas as an Illuminant for Polariscopic Work. H. W. Wiley (Account of an experimental examination into the application of this illuminant to polariscopic work, resulting favorably to its usefulness). Jour of Am Chem Soc–Feb. 700 w.

†4072. Indirect Analysis. Edward K. Landis (New formula for analysis, applicable upon the supposition that the present atomic weights should be modified, and applicable to any case wherein the atomic weights are not the same). Jour of Am Chem Soc–Feb. 900 w.

†4074. High Pressure Gas Bottles. From paper by M. Périssé (Conditions under which explosions are likely to occur. Precautions to be observed in filling. Rules as to quantity permissible in bottles of given capacity. Government regulations, etc). Ind Engng–Jan. 4. 1200 w.

*4076. The Best Milling Systems. From a paper by W. A. Holley, read before the Mich. Millers' Assn. (Hints by a practical miller which will aid in the production of the maximum quantity of high grade flour, from the minimum quantity of wheat. The various systems in use are named and their common purpose is the same). Am Miller–Feb. 1500.

We supply copies of these articles. See introductory.

BOOKS OF MONTH

Carpenter, Rolla C. Heating and Ventilating Buildings. J. Wiley & Sons, New York. 1895. Cl. $3.

Cross, Anson K. Free Hand Drawing. A Manual for Teachers and Students. Ginn & Co., Boston. 1895. Cl. 65c.

Cross, Anson K. Mechanical Drawing. A Manual for Teachers and Students. Ginn & Co., Boston. 1895. Cl. $1.10.

Bovey, H. T. A Treatise on Hydraulics. John Wiley & Sons. 1895. Cl. $4.

Groves, C. E., and Thorp, W. Chemical Technology. Vol. 2. Lighting. P. Blakiston, Son & Co., Philadelphia. 1895. Cl. $4. Half Morocco, $5.50.

Leffman, H., M. D. Examination of Water for Sanitary and Technic Purposes. 3d Ed. Macmillan & Co. 1895. Cl. $1.25.

Thompson, J. J. Elements of the Mathematical Theory of Electricity and Magnetism. Macmillan & Co., N. Y. 1895. Cl. $2.

Nicholson, J. Shield. A Treatise on Money, and Essays on Monetary Problems. Macmillan & Co., New York. 1895. Cl. $2.

Webb, W. L. Problems in the Use and Adjustment of Engineering Instruments: Forms for Field Notes. J. Wiley & Sons, New York. 1895. Cl. $1.

Wheeler, D. Hilton. Our Industrial Utopia and its Unhappy Citizens. A. C. McClurg & Co., Chicago. 1895. Cl. $1.25.

Du Bois, A. J. The Elementary Principles of Mechanics. Vol. 3. Kinetics. J. Wiley & Sons, New York. 1895. Cl. $3 50.

Johnson, Emery R. Railway Departments for the Relief and Insurance of Employees. Publications of American Academy of Political and Social Science. Philadelphia. 1895. Pap. 35c.

Lippincott's Gazeteer of the World. Rev. ed. of 1895, with Tables of Latest Census Returns. J. B. Lippincott Co., Philadelphia. Sheep, $12. Half Turkey or Half Russia Morocco, $15. In two volume, sheep $15. In two volume half Turkey or Russia, $18.

Lock, G. W. Warnford. Economic Mining. A Handbook for the Miner, Metallurgist, and the Merchant. Spon & Chamberlain, New York. 1895. Cl. $5.

Rhead, E. L. Metallurgy. An Elementary Text-Book. Longmans, Green & Co., New York. 1895. Cl. $1.25

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NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

W. F. & John Barnes Co., Rockford, Ill., U. S. A.=Price List and Descriptive Catalogue of Barnes Patent Foot and Hand Power Wood Working Machinery.

General Electric Company, Schenectady, N. Y., U. S. A.=(a) Portfolio of Engravings in half-tone of Exhibits at the World's Fair, Chicago, and at the Cotton States and International Exposition at Atlanta, together with a large number of illustrations of installations made by this company in various parts of the world. (b) Pamphlet, on transmission of Power, for railways shops, mines, etc. (c) Elegantly printed pamphlet describing the Thomson Watt-Meter, with list of sales offices, price-chart for determining the amount of bills, at various rates per 1000 watt-hours, and other useful information.

Pemberthy Injector Co., Detroit, Mich.= Calendar handsomely printed in colors, the work of the Pemberthy Press which this establishment now uses for printing a great variety of circular advertising matter. As a work of art this is a piece of printing highly creditable to the firm.

Continental Iron Works, Brooklyn, N. Y.=A Treatise on the Morison Suspension Furnaces, with numerous illustrations and a large amount of general information relating to this successful invention. Important testimonials are appended.

Ingersoll Sergeant Drill Co., New York= Pamphlet describing with numerous illustrations, machinery, appliances, and methods used in the construction of the Chicago Drainage Canal.

Lehigh University, South Bethlehem, Pa.= Pamphlet describing courses of study, apparatus and methods, in this now celebrated institution.

Knowles Steam Pumps Works, New York= Special Catalogue of Electric Power Pumps.

The Norwalk Iron Works Co., South Norwalk, Conn., U. S. A.=Beautifully printed and elegantly illustrated catalogue descriptive of the Norwalk Air and Gas Compressor, especially designed for driving coal cutters, rock drills, pumps, engines, pneumatic locomotives, and other mining machinery, and also claimed to be the best machine for compressing air for all dynamic purposes, for liquefying carbonic acid, and for pumping natural gas.

The Gould's Manufacturing Co., New York =Special Catalogue, 1896, and Price List of Pumps and Spray Nozzles.

Fraser & Chalmers, Chicago, Ill., U.S.A. and London, England=Interesting pamphlet describing and illustrating Wood's Dry Placer Miner manufactured solely by this firm, and intended for use on gold fields lacking water supply, wherein it is said to have proved a grand success.

Scientific Machinist Co., Cleveland, Ohio= Pamphlet, illustrating the system and apparatus for home study of engineering supplied by The Institute for Home Study of Engineering under direction of the company.

The Standard Boiler Co., Chicago, Ill., U. S. A. Works at Link Belt Machinery Co., Chicago, Ill.=Pamphlet illustrating and describing the "Standard Water Tube Safety Boiler." One of the illustrations is that of a 4,000 h. p. installment now in process of erection for North Chicago Street Railroad Company.

Buffalo Forge Co., Buffalo, N. Y., U. S. A.= Circulars. (a) For Foundries: "A French Iron Foundry in 1879" (b) For wood-working concerns: "Air as an Industrial Factor." The purpose of this unique system of advertising is to draw attention to, and secure inquiry for a large sectional catalogue illustrating and describing the particular line of goods manufactured by the company, which includes a fan system for seasoning timber, rotary fan blowers, portable forges, high speed engines for dynamos, blowers for cupolas, etc., etc.

B. F. Sturtevant & Co., Boston, Mass., U. S. A.=A most elegantly printed pamphlet (a beautiful specimen of artistic printing) entitled "A Century of Progress," which is a brief but very interesting history of a company, whose name has become permanently identified with the industrial progress it has done so much to further.

The Link-Belt Engineering Co., Nicetown, Philadelphia, Pa., U. S. A.=Pamphlet illustrating and describing the "Monobar" Link-Belt and its applications to the elevation and conveying of materials. One of the engravings illustrates a plant erected last year for the N. Y., L. E. & W. Railway Co., at Buffalo, N. Y.

The Trenton Iron Co., Trenton, N. J., U. S. A.=Treatise entitled "Wire Rope Transportation in All Its Branches," including wire rope tramways, quarry cableways, mine haulage plants and power transmissions. Illustrated with numerous engravings of interesting and important installations, etc.

The Best Manufacturing Co., San Leandro, Cal., U. S. A.=Catalogue illustrating and describing a line of gas or gasoline, and crude oil engines.

Harrison Bros. & Co., Philadelphia, Chicago and New York, U. S. A.=Pamphlet entitled "The Painting of Metallic Surfaces." An interesting and instructive essay.

Edwin Harrington, Son and Company, Incorporated, New York, U. S. A.=Pamphlet entitled "Pointer No. 1." The New Harrington Hoist. Illustrates and describes a complete system, for hoists, traveling cranes, and tramway.

J. H. McEwen Manufacturing Company, New York, U. S. A.=Elegantly illustrated catalogue, describing automatic cut-off engines made by this firm including simple, and tandem compound, with tables of powers and dimensions.

IMPROVED MACHINERY

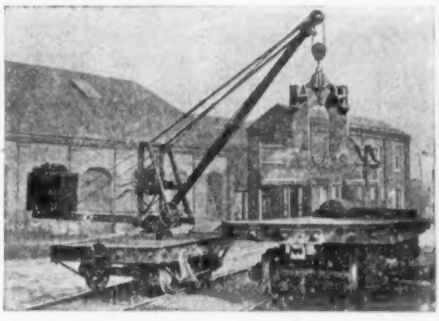
NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Truck Mounted Revolving Crane.

THIS is a convenient and effective device for general service of railroad companies, ship yards, foundries, and in short any industry or situation where large and heavy pieces are required to be handled. As compared with its initial cost, the economy of such a device must be great; and there are easily imagined circumstances under which it might pay for itself over and over in a single year.

We are informed that this arrangement is sold cheaper than anything of like capacity and purpose now on the market, and it is claimed to be superior to any of its competitors. In large engineering and construction work it finds one of its most important applications.



TRUCK MOUNTED REVOLVING CRANE.

The truck may be made to correspond to any usual gage of track, and has pin coupling, on standard gage truck, at standard height above rail. The size of standard gage truck floor is 7 × 14 feet.

To provide for raising and lowering the jib it is secured to the top of the frame from its upper end by means of telescoping wrought iron pipes secured in any position by suitable pins. The frame is of well braced and riveted angle iron. The load is counter-balanced as shown. An extension of the frame rearward forms a track upon which the counterbalancing weight can be run out to the exact distance required. The trucks are provided with the usual draw-bars, etc.

The frame of the crane is pivoted on a heavy steel pin, cast solid in the truck center plate, the latter being recessed for the reception of roller bearings upon which the plate carrying the crane and the load turns easily. A friction brake holds the load at any height to which it may have been elevated. The specifications for the various parts of the machine indicate that the utmost care in the selection of materials, and in the workmanship, is exercised in the construction of these cranes. The lifting capacity is two tons.

These cranes are manufactured by the Middletown Car Works, Middletown, Pa.

"Steel End" Hose.

THIS is the commercial name of a new brand of hose, designed especially for garden and hydrant use, which the N. J. Car Spring & Rubber Company of Jersey City, N. J., have already added to their already very complete line of hose. It is of the same high grade of manufacture as all the other products of this company, but differs radically from their regular brands of hose, in the ends, which are fashioned in the manner shown in the engraving. It is the common experience of all who have occasion to use hose, especially the smaller sizes, to find that in a short time it becomes broken at the ends because of the short and frequent bending it receives, just where the couplings are attached.

The result of this breaking of the hose is an annoying and wasteful escape of water at these points, which not only diminishes the pressure at the nozzle, but generally succeeds in wetting the user of the hose from head to foot. There is no possibility of this occurring with the steel end hose. Between the plies of duck at the ends of each section is inserted a steel spiral, which not only adds materially to the strength of the

hose, but effectually prevents it from bending at these points, insuring longer life and greater cleanliness and comfort in its use. The plan is

"STEEL END" HOSE.

so plainly an improvement and so full of every-day common sense that it cannot fail to commend itself to the trade generally. Prices and samples, we are informed, may be obtained from the manufacturers.

A New Recording Thermometer for Atmospheric Ranges of Temperature.

THE novel and especially valuable feature of the recording thermometer herein described is that the recording portion may be located at a distance of twenty five or thirty feet from the point at which the temperature is to be measured. This makes it possible to obtain a continuous record of the outside temperature while the recorder is located at a convenient point within doors where it may be readily observed and its mechanism is not exposed to the detrimental influences of inclement weather. For cold storage plants where closed rooms are to be maintained at a constant temperature for the preservation of meats, fruits and vegetables, an instrument of this kind is of great value as the temperature may be observed without opening the doors.

The recording part (Fig. 1.) is an application of one of Bristol's recording pressure gauges. Fig. 3 shows an interior view of the recorder, which consists of a pen arm directly attached to the free end of a tube of flattened cross-section bent into helical form. The bulb portion (Fig.2) is placed at the point where temperature is to be measured. It consists of a series of helical tubes constructed on the same principel as that in the recorder. The helical coils are suspended in a vertical position with their lower ends free, the upper ends opening into the capillary tube connecting them with the recorder. The system of helical tubes forming the bulb portion, the pressure tube of the recorder and the capillary connecting tube are completely filled with alcohol under pressure and permanently sealed. As temperature rises and falls where the bulb is located, there is a corresponding expansion or contraction of the alcohol which is communicated to the recorder and registered on a seven-day chart graduated to read in degrees Fahrenheit.

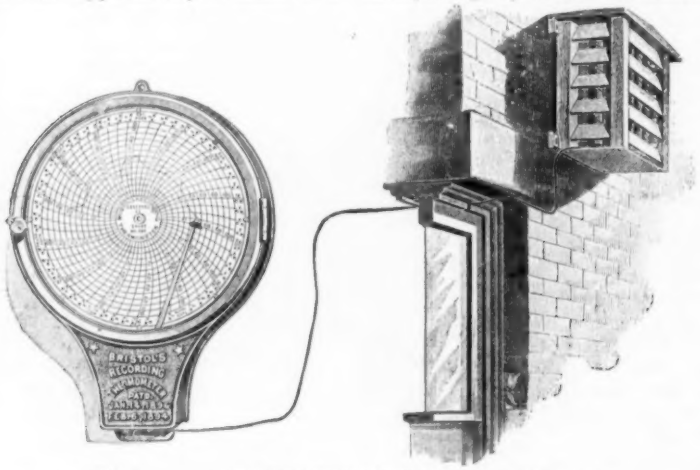


FIG. 1. RECORDING THERMOMETER. FIG. 2.

Excessive pressures due to increased volume of the non-compressible liquid are provided against by the expansible form of the system of helical tubes of which the bulb is constructed. The total volume of the bulb portion is very large as compared with that in the pressure recorder, thus avoiding the necessity of compensating for ordinary changes of temperature in the room where the recorder is located. No correction is required for barometric changes, as only high ranges of pressure are employed.

This thermometer is being manufactured and placed on the market by The Bristol Co. of Waterbury, Conn. At 121 Liberty street, the New York branch of the company, one of the instruments may be seen in operation recording the outside temperature.

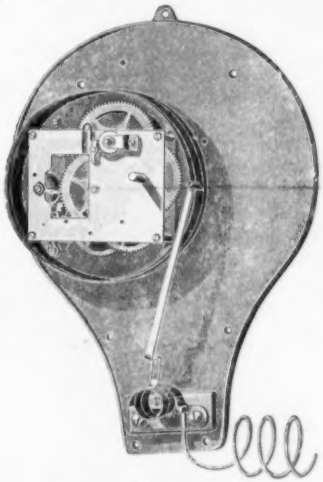


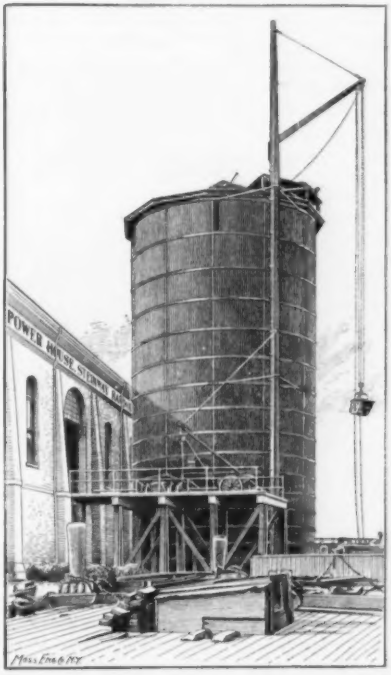
FIG. 3.
RECORDING THERMOMETER.

Design for Coal Pocket.

A VERY important element in the designing and building of Power Plants is the question of the proper storing of coal. No power plant should be designed without providing for the storage room for from 500 tons to 1000 tons of coal, and in larger plants this capacity should be very much increased. The danger of a strike in a coal region, or delays in transportation incident to strikes, weather, floods, etc., are so many and great that no power plant should take these risks, but all should provide storage for sufficient coal to provide against a contingency of this kind. The difficulties in designing a proper bin or pocket for storing this coal are many and great, owing to the large floor space required.

Our attention has been called to a pocket lately designed by the Berlin Iron Bridge Co., of East Berlin, Conn. for the power house of the Steinway Electric R. R. Co., at Astoria, which has attracted much attention. This design is unique and possesses many points of merit, owing to the large amount of storage capacity in proportion to the exceedingly limited amount of floor space occupied. The general appearance is shown in the accompanying illustration, which is taken from a photograph of the completed pocket, in operation. Especial attention is called to the cylindrical form of construction. This particular pocket is 28 ft. in diameter, 54 ft. in height, and has a capacity of 1000 tons of coal. The coal is unloaded from the barge or carts, at the side of the pocket in the ordinary way, and hoisted by means of a bucket to the top of the pocket, so that no expensive machinery is required to fill the pocket, an ordinary hoisting engine being all that is necessary. Of course, more expensive mechanical appliances might be introduced for doing this work, in the shape of an endless chain or some of the other appliances of a similar nature, but we doubt very much whether the revenue would pay the interest on the incurred cost over the apparatus shown in the illustration.

There is an opening in the side of the pocket, near the base, for removing the coal in the ordinary way, so that it can be carried into the boiler room by means of an endless chain, with buckets, or by hand, or by carts, or what ever way may be desired. The advantage of this



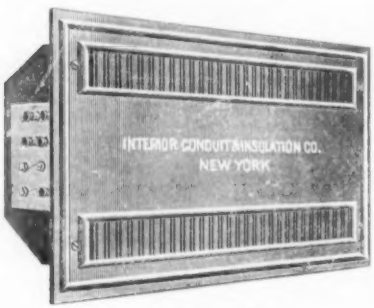
DESIGN FOR COAL POCKET.

pocket does not lie in its presenting any additional facilities for handling the coal, but more in its being an economical method of storing coal, and as such, it offers many advantages and commends itself to owners of large steam plants, as it admits of greater capacity in proportion to the floor surface, than any methods that have lately come to our attention. The patents on this construction are owned and controlled by the Berlin Iron Bridge Co., of East Berlin, Conn.

A New Electric Car Heater.

THE Interior Conduit and Insulation Company of New York have introduced this season an electric car heater, which, they claim embodies great improvements in this class of apparatus. A much higher efficiency has been obtained in these Heaters over other machines which have heretofore made their appearance; and this economy of operation is by far the most important factor to any railway company. Electric heaters are not all of equal efficiency. It is not sufficient merely to create heat; it must be utilized to the best advantage; in order to do this, it is imperative that the heat should be distributed and circulated where it is needed, and as fast as it is generated.

In the heater manufactured by the Interior Conduit and Insulation Company, a continual circulation of air is maintained. All the air passes through the coils, and all the heat generated is carried off and distributed into the body of the



ELECTRIC CAR HEATER.

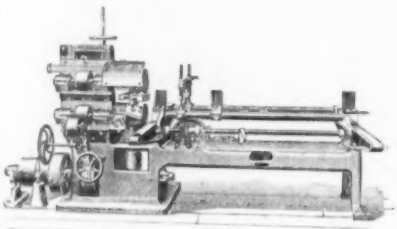
car, the case of the heater remaining perfectly cool. There is absolutely no waste, and consequently a much higher degree of efficiency is obtained than has hitherto been practicable. These heaters are thoroughly well made, neat in appearance, easily installed, and are amply guaranteed.

No. 5 1-2 Heavy Car Tenoner.

THIS recent addition to the line of car-shop tools manufactured by the Egan Co., 212 to 232 West Front St., Cincinnati, Ohio, is designed for cutting single and double tenons on large timbers, and is especially adapted for the use of car and bridge builders, and wherever large single or double tenons are required.

The main column is a heavy hollow casting with an extension supporting the bed, and ample floor space to insure steady running. It is heavy enough throughout to withstand any vibration.

A table of ample proportion is moved on planed ways, by a rack and pinion at each end, thus causing it to move parallel, without undue friction on the ways. Large friction cones drive the pinions, and the table returns at about twice the speed at which it goes forward to the cut. The movement of the table is controlled by a lever, and the pressure applied governs its travel accordnig to the width of tenon to be cut.



HEAVY CAR TENONER.

The center support is adjustable for long or short stock; gauge rods regulate the length of the tenon, and suitable devices hold the stock in position.

The steel mandrels are of large diameter, and run in long self oiling boxes, with pulleys placed between them; a belt tightener gives the cutter heads ample power for a heavy cut.

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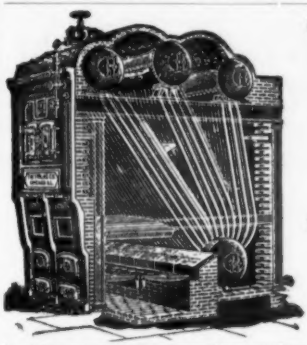

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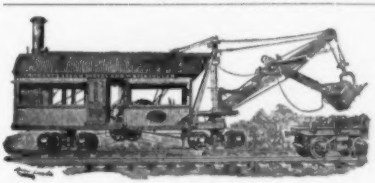

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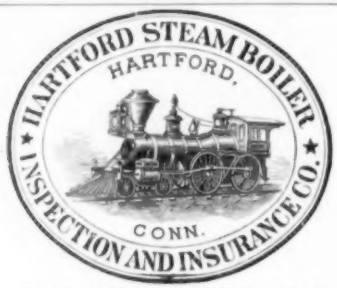

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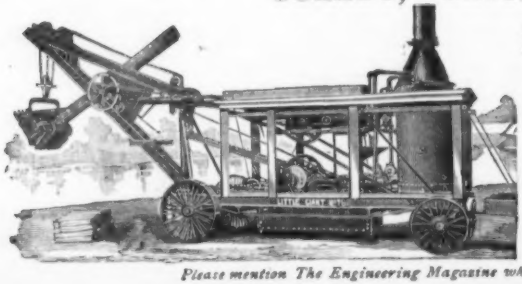

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AUTHORS AND PAPERS THIS MONTH.

WILLIAM P. STEPHENS (*International Racing and National Supremacy on the Sea*)—Has been for the past dozen years in charge of the yachting and canoeing departments of *The Forest and Stream*, and is known as a careful student of yachting and an expert writer on yachting, canoeing, and naval architecture in its application to pleasure craft. Mr. Stephens graduated from the Scientific School of Rutgers College in 1873, going at once into railroad engineering, but after a time turning to marine work and entering Roach's Shipyard at Chester, Pa. Later on he took up the building of canoes and small yachts, at first as an amateur and later as a regular business, giving it up to assume his present position on the staff of the *Forest and Stream*. His book on "Canoe and Boat Building for Amateurs" is recognized as the standard work on boat building, and in addition to much technical writing on design and construction he has designed many successful small craft. Mr. Stephens has taken a very active part in the discussion and amendments of yachting rules, and through his writing has contributed in no small degree to the advancement of a knowledge of yachting and designing.

A NATIVE CUBAN (*The Revolt in Cuba: Its Causes and Effects*)—The Cuban gentleman who contributes the article which we publish in this issue under the above title is well known in the Spanish-American Colony of New York, as a scholar in his own, as well as in the English language; and being thoroughly conversant with all matters relating to his native country, is, therefore, in a position to fully appreciate the true Cuban sentiment regarding the present revolution. The name of this gentleman is withheld from publication because several members of his family are residents of Cuba and consequently within the power of the Spanish government.

JAMES SMITH ROBERTSON (*The Canadian Lumber Industry*)—Born in Toronto, Can., April 6, 1853; educated in the public schools of his native city; of a studious disposition, and from boyhood given to extensive reading; was brought up a bookseller, and for a number of years was engaged in book publishing; a contributor to the local press and various journals of his own country for more than twenty years; publisher and editor *Whitby Chronicle*, of Whitby, Ont., from 1883 to 1886; in April, 1890, became editor of *Canada Lumberman* and *Canadian Miller*; in Sept., 1894, the latter was merged into the *Northwestern Miller*, of Minneapolis, Minn., when Mr. Robertson was appointed agent and correspondent for Canada, a position he holds to-day. For nearly two years he was on the editorial staffs of the *Canadian Electrical News* and *Canadian Architect and Builder*. These positions he resigned Sept. 1 of this year to give his time more fully to other newspaper interests that have engaged his attention for some time. He is the Canadian correspondent of *The Timberman*, of Chicago, *The American Contractor*, of Chicago and New York, and a contributor to *The Electrical World* and *Electrical Railway Gazette*.

R. PHENE SPIERS, F. R. I. B. A., F. S. A. (*Architectural Students' Work Abroad*)—Master of the Architectural Schools of the Royal Academy; author of "Architectural Drawing," etc.; editor of the new edition of Fergusson's "History of Architecture in all Countries"; a frequent contributor to the English magazines and professional journals; one of the most scholarly and distinguished of English architects; most of his life, however, has been spent in teaching and in extended architectural and archæological research that has made him probably the best equipped living historian of architecture. He was one of the first Englishmen to study at the École des Beaux Arts in Paris; has travelled extensively on the Continent and in the East. In addition to the many distinctions he enjoys as an architect, a teacher, and a writer, Mr. Spiers has a wide reputation in England as a water colorist of the first rank.

PATRICK BERNARD DELANY (*The Future of the Electric Telegraph*)—Born Kings County, Ireland, 1845; educated private and parochial schools Ireland and America; learned telegraphy in Hartford, Conn., at an early age; occupied various positions from office boy to superintendent of lines; expert practical operator, newspaper correspondent, editor and writer; inventor anti induction cables, synchronous multiplex telegraphy, automatic systems for ocean cables, and rapid machine telegraphy for land lines, comprising in all about 150 patents; member and ex vice-president American Institute Electrical Engineers; member Franklin Institute, from which he has received the Elliott-Cresson gold medal and the John Scott (legacy) medal for his inventions; awarded gold medal and diploma at International Inventions Exhibition, London, 1885, for synchronous multiplex telegraph system, afterwards adopted and now extensively used by British post-office. Mr. Delany has just perfected a system of automatic telegraphy capable of transmitting and plainly recording 3000 words per minute over a single wire, and with which he proposes the inauguration of letter telegraphy, or a virtual carrying of the United States mails between cities.

ARTHUR LAKES (*The Newhouse Tunnel at Idaho Springs*)—Born in Martock, Somersetshire, England, in 1843; educated first at Elizabeth College, Guernsey, Channel Islands, and later at Oxford University; thence he went to Canada and later to the United States; at Chicago he met the late Bishop Randall and joined him in planting a church school in Colorado in the pioneer days of 1870; soon he turned his attention to his favorite study of geology and discovered the Atlantosaurus Dinoram, the greatest known land animal; he also contributed many new discoveries in fossil plants to the Hayden Survey; later he was engaged under the United States Geological Survey in the survey of the Leadville region under Mr. S. F. Emmons as artist and assistant geologist; later he accepted the chair of geology at the State School of Mines at Golden, Colorado; he has written many treatises and popular articles on the geology and economic products of Colorado, especially on the coal and metal deposits.

JAS. R. MAXWELL (*Mountain Railroads of the Mining Regions*)—Began work on the Pennsylvania Railroad, and was with the Union Pacific Railway from Columbus (about 90 miles out) until it was finished; after that was with the Adirondac and the Northern Pacific railroads; then in Peru, as division engineer of the Cuzco road; chief engineer of the Chimbote road, and chief engineer of public works at Cerro de Pasco; from 1879 to 1882 was chief engineer of explorations, surveys and construction in Virginia, Kentucky, Illinois and Missouri; again with the Union Pacific, on construction and surveys in Idaho and Montana, and later as locating engineer on lines from Salt Lake City towards San Francisco, Los Angeles and San Diego; went to Peru for the third time in 1890 as chief engineer for the contractor, and finished the Central Railroad of Peru from Chicla to Oroya in 1893. At present in private practice.

W. L. HEDENBERG (*Future Method of Sewage Purification*)—Born in New York city, 1869; studied at Heidelberg and other schools abroad; graduate of Princeton University with degree of C. E.; is associate member American Society of Mechanical Engineers and associate member American Institute of Electrical Engineers; has invented a number of electrical appliances and is a frequent contributor to the engineering journals; began his professional career as assistant engineer Central Railroad of New Jersey; later, civil engineer for Metropolitan Telephone Company, of New York; at present member of firm of Hedinberg & Kinsey, civil and sanitary engineers, practicing with headquarters in New York city.

HOWARD V. HINCKLEY (*Underflow as Related to Irrigation*)—Graduated at Worcester Polytechnic 1876; one season on Hoosac Tunnel line; three years draftsman and field engineer Atchison, Topeka and Santa Fé Railroad Company; twelve years assistant to chief engineer same company, in charge of designs for track, bridges, buildings, water service and terminals; two years, to date, devoted entirely to study of water supply of the great plains; consulting engineer of Kansas Irrigation Association and Kansas Board of Irrigation; member American Society Civil Engineers, Kansas Academy of Science, etc. Mr. Hinckley has made hundreds of experiments to determine the laws of the underflow, the practical methods of developing it and its importance for irrigation and domestic supply.

ALBERT WILLIAMS, JR. (*Racial Traits in Machine Designing*)—Born in San Francisco in 1852; graduated from Phillips Academy, Andover, 1868; from Princeton, 1872; of which institution he is a fellow in experimental science; took a special course at the Columbia College School of Mines, 1872–73; has had wide practice as a mining and metallurgical expert in various districts of this country and Mexico; formerly chief of the division of mining statistics and technology of the United States Geological Survey, organizing that service and publishing the annual reports from 1882 to 1885; organized the Michigan Mining School at Houghton, 1886–87; as a writer on scientific, technical and economic subjects has contributed largely to the scientific and technical press during twenty years.

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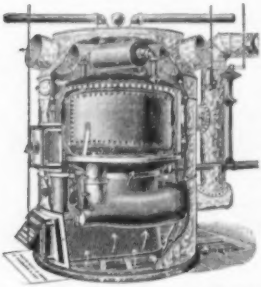

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Alphabetical Index. Page 17.

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Alton D. Adams, Worcester, Mass.
D. Ashworth, Pittsburg, Pa.
Wm. H. Bryan, St. Louis, Mo.
C. M. Conradson, Madison, Wis.
E. L. Corthell 71 Broadway, New York.
Lewis K. Davis, 66 Broadway, New York.
Dr. Willis E. Everette, Tacoma, Wash.
M. Fargusson, Southport, N. C.
Wm. B. Fuller, Boston, Mass.
C. T. Gooding, Tucson, Ariz.
E. B. Hussey, Seattle, Wash.
E. P. Jennings, Ironwood, Mich.
Julian Kennedy, Pittsburg, Pa.
A. L. McRae, Austin, Texas.
Frank Nicholson, Phoenix, Ariz.
Pittsburg Testing Lab'y, Ltd., Pittsburg, Pa.
Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
Vandenbergh Lab'y of Chem. Ind., Buffalo, N. Y.
Wm. O. Webber, Boston, Mass.
Nisbet Wingfield, Atlanta, Ga.

Contractors' Dump Cars, etc.

Gates Iron Works, Chicago, Ill.
Sheffield Car Co., Three Rivers, Mich.

Contractors' Supplies

F. C. Austin Mfg. Co., Chicago, Ill.
Thomas Carlin's Sons, Allegheny, Pa.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.

Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
W. J. Clark & Co., Salem, Ohio.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link Belt Engineering Co., Phila., Pa.

Copper.

Canadian Copper Co., Cleveland, O.

Corliss Engines

Edw. P. Allis Co., Milwaukee, Wis
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio
Maryland Steel Co., Sparrows Point, Md.
Robt. Wetherill & Co., Chester, Pa.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Merchant & Co., Phila., Pa.
Wheeling Corrugating Co., Wheeling, W. Va.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Crushers, Ore, Phosphate, Rock.
Edw. P. Allis Co., Milwaukee, Wis.
F C. Austin Mfg. Co., Chicago. Ill.
Bradley Pulverizer Co., Boston, Mass.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago. Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Sturtevant Mill Co., Boston. Mass.

Diamond Drills.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.
Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.
Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.
Wm. E. Stieren, Pittsburg, Pa.

Dredging Machines.
W. J. Clark & Co., Salem, Ohio.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio
Maryland Steel Co., Sparrows Point Md.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.
W. F. & J. Barnes Co., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Presses.
Merrill Bros., Brooklyn, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co, Sparrows Point, Md.

Dynamos.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Shawhan-Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electric Railway Supplies.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Morris, Tasker & Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Instruments.
Bristol Co., Waterbury, Conn.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Queen & Co., Inc., Philadelphia, Pa.
Shawhan-Thresher Electric Co., Dayton, O.
Standard Electric Co., Chicago, Ill.
Standard Thermometer Co., Peabody, Mass.
Triumph Electric Co., Cincinnati, Ohio.
United Electric Telephone Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co, 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
H. K. Porter & Co., Pittsburg, Pa.

Electrical Rubber Goods.
Home Rubber Co., Trenton, N. J.
Spinney, Virtue & Co., Lynn, Mass.

Electroplating and Electrotyping Machines.
Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Elevator Buckets.
W. J. Clark & Co., Salem, Ohio.

Elevator Guards and Screens.
Harrington & King Perforating Co., Chicago, Ill.

Elevators, Steam, Hydraulic, Electric.
M. J. O'Donnell & Co., Cleveland, Ohio.

Emery Wheels.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.
Theo Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
Wm. E. Stieren, Pittsburg, Pa

Engines, Blowing.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Southwark Foundry and Machine Co., Phila., Pa
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petrol um.
Otto Gas Engine Works, Philadelphia, Pa.

Engines, Marine.
Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Poin

Engines, Stationary.
American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Southwark Foundry and Machine Co., Phila., Pa
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Robert Wetherill & Co., Chester, Penn.

Evaporators.
Wheeler Condenser & Eng. Co, 39 Cortlandt St., N. Y

Excavators.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Expansion Tanks.
Hepe, Koven & Co., 18 Spruce St., N. Y.

Extensible Sewer Brace.
Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Fans, Ventilating.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.

Feed-Water Heaters.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.

National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng Co., 39 Cortlandt St., N.Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Files.

Nicholson File Co., Providence, R. I.

Filters.

Continental Filter Co., 44 Wall St., N. Y.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.

Fire Arms.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass

Fire Department Equipment.

American Ball Nozzle Co., 837 Broadway, N. Y.

Fireproof Building Material.

Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Empire Fire Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
James L. Foote, Slatington, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Merchant & Co., Philadelphia, Pa.
Milton Mfg. Co., Milton, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Riter & Conley, Pittsburg Pa
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co. Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, M
Walker Manufacturing Co., Cleveland, Ohio.

Foot and Hand Presses.

Toledo Machine & Tool Co., Toledo, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.

Forgings.

Milton Mfg. Co., Milton, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.

Furnace Builders.

Fraser & Chalmers, Chicago, Ill,
Julian Kennedy, Pittsburgh, Pa.
Riter & Conley, Pittsburg, Pa.

Furniture.

The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.

C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure, Steam, Water, etc.

Bristol Co., Waterbury, Conn.
Crane Company, Chicago, Ill
Crosby Steam Gage and Valve Co., Boston, Mass.
The Fairbanks Co., New York.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Coldwell-Wilcox Co., Newburgh, N. Y.
Continental Iron Works, Brooklyn, N. Y.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.

Gear Cutters.

Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
General Electric Co., 44 Broad St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grading Machines.

F. C. Austin Mfg. Co., Chicago, Ill.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates and Hearths.

Samuel H. French & Co., Philadelphia, Pa.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hand Cars.

Sheffield Car Co., Three Rivers, Mich.

Hangers.

SEE PULLEYS, ETC.

Hardwood Floors.

E. B. Moore & Co., Chicago, Ill.

Hardware Manufacturers.

Charles H. Besly & Co., Chicago, Ill.
Merrill Bros., Brooklyn, N. Y.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass

Heating and Ventilating Apparatus.

Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Huyett & Smith Mfg. Co., Detroit, Mich.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

American Boiler Co., Chicago, Ill.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
S. Wilks Mfg. Co., Chicago, Ill.
United States Heater Co., Detroit, Mich.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio

Hod Hoisting Machinery.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Hollow Bricks.
Empire Fire-Proofing Co., Pittsburgh, Pa.

Hose, Steam and Fire.
Crosby Steam Gage and Valve Co., Boston, Mass
Home Rubber Co., Trenton, N. J.

Hydraulic Machinery.
Fraser & Chalmers, Chicago, Ill.
New York Belting & Packing Co., Ltd., New York
Maryland Steel Co , Sparrows Point, Md
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.
Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.
Crosby Steam Gage and Valve Co., Boston, Mass.
Queen & Co., Inc., Philadelphia, Pa.

Injectors.
American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.
W. R. Brixey, 203 Broadway. N. Y.
Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
The Okonite Co., Limited, 13 Park Row, N. Y.

Insulating Paper.
Standard Paint Co., 2 Liberty St., N. Y.

Iron Working Machinery.
Charles H. Besly & Co., Chicago, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Merrill Bros., Brooklyn, N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
The Wilkinson Co , Chicago, Ill.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Joists, Iron and Steel.
Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Lamps, Electric.
General Electric Co., 44 Broad St., N. Y.
Standard Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.

Lead Corroders.
Harrison Bros. & Co., Philadelphia, Pa.

Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
H. K Porter & Co., Pittsburg, Pa.
Thomas Carlin's Sons, Allegheny, Pa,

Locomotive Brakes.
Westinghouse Air Brake Co., Pittsburgh, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Lubricants.
Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.
Sherwood Mfg. Co., Buffalo, N. Y.

Lumber and Shingles.
Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Machine Screws, etc.
Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.
Armstrong Bros. Tool Co., Chicago, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Charles H. Besly & Co., Chicago Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Merrill Bros., Brooklyn, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N, Y.
Q. & C. Co , Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
The Wilkinson Co , Chicago, Ill.

Mantels.
Samuel H. French & Co., Philadelphia, Pa.

Marine Machinery
W. A. Crook & Bros Co., Newark, N. J.
Marine Iron Works, Chicago, Ill.

Mathematical Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co , Philadelphia, Pa.
L. S. Starrett, Athol, Mass.
Wm. E. Stieren, Pittsburg, Pa.

Merchant Steel.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Metal Punching and Shearing.
Harrington & King Perforating Co., Chicago, Ill.

Meters, Electric.
General Electric Co , 44 Broad St., N. Y.

Meters, Water.
Deane Steam Pump Co., Holyoke, Mass.

Milling Machines
Ingersoll Milling Machine Co., Rockford, Ill.

Mining Machinery.
Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
W. A. Crook & Bros. Co., Newark, N. J.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Mining Screens.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Mortar Colors.
Samuel H. French & Co., Philadelphia, Pa.

Motors, Electric.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co , Columbus, Ohio.
Shawhan-Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Nickel.
Canadian Copper Co., Cleveland, O.

Nut Locks.
Eureka Nut Lock Co., Pittsburg, Pa.

Oil Cups.
Sherwood Mfg. Co., Buffalo, N. Y.

Ore Roasting Machinery.
F. D. Cummer & Son Co., Cleveland, Ohio.

Ornamental Iron Work.
Winslow Bros. Co., Chicago, Ill.

Packing
The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Sherwood Mfg. Co., Buffalo, N. Y.

Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Samuel H. French & Co., Philadelphia, Pa.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
Harrison Bros. & Co., Philadelphia, Pa.
Standard Paint Co., 2 Liberty St., N. Y.

Paints (Special for Iron.)
SAME AS ABOVE.

Paper Mill Machinery
Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Penstocks.
Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds).
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Merchant & Co., Philadelphia, Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.
Rochester Optical Co., Rochester, N. Y.

Pipe, Cast Iron.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
Jeanesville Iron Works, Jeanesville, Pa.
Charles Millar & Son, Utica, New York.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.
National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.
Manville Covering Co., Milwaukee, Wis.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Pipe Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.

Pipe, Sewer.
Charles Millar & Son, Utica, New York.
Union Sewer Pipe Co., Akron, Ohio.

Pipe, Wrought Iron, Line and Drive.
Crane Company, Chicago, Ill.
Morris, Tasker & Co., Philadelphia Pa.

Planing Mill Machinery.
C. B. Rogers & Co., Norwich, Conn.

Plaster Ornaments.
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Toledo Machine & Tool Co., Toledo, Ohio.
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Power Transmission, Electric.
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Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

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Pulley Lathes.
W. F. & J. Barnes Co., Rockford, Ill.
Fitchburg Machine Works, Fitchburg, Mass.

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Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works, Dayton, Ohio
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Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

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Bradley Pulverizer Co., Boston, Mass.
Fraser & Chalmers, Chicago, Ill.

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Fraser & Chalmers, Chicago, Ill,
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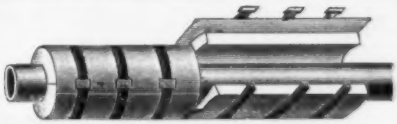

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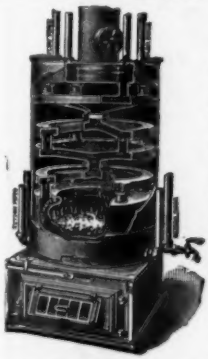

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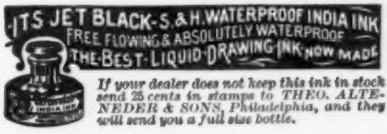

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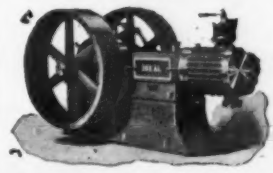

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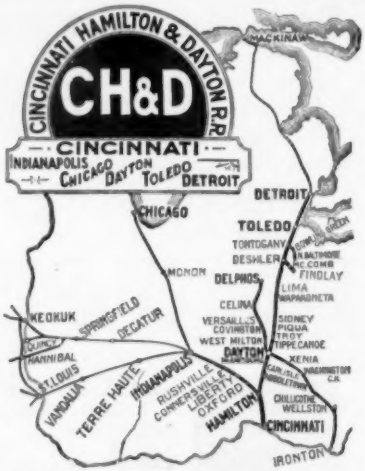

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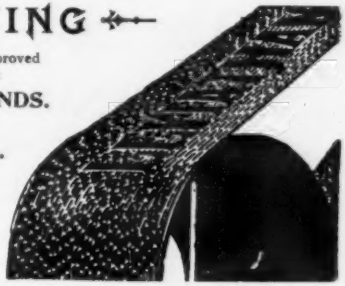

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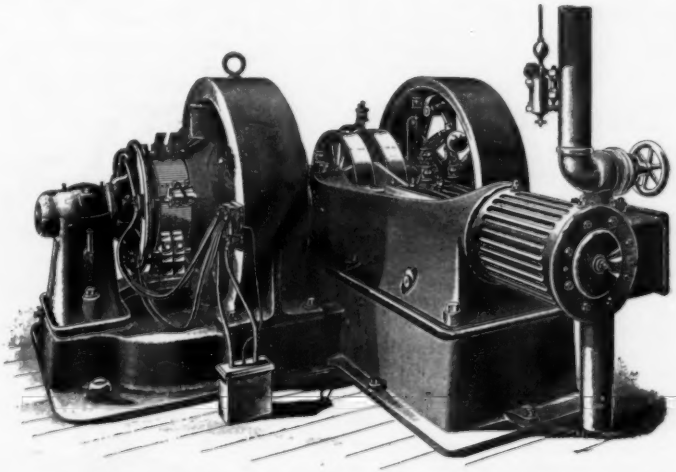

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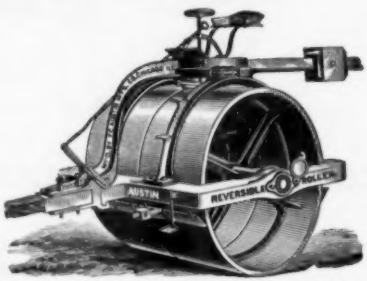

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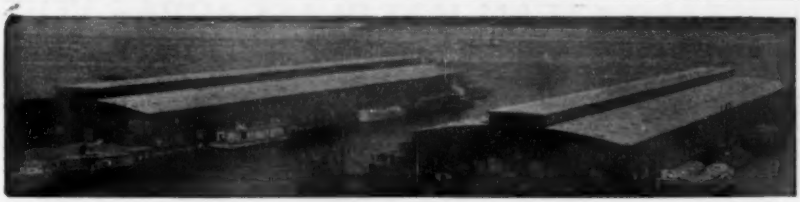

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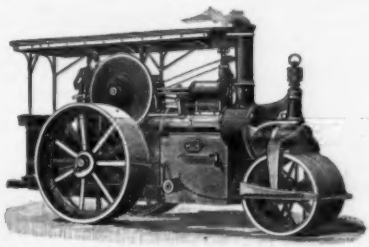

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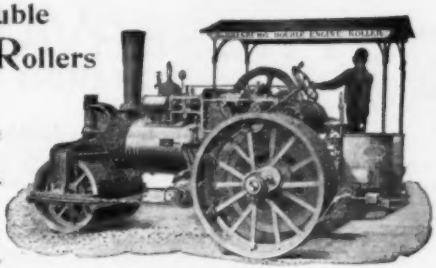

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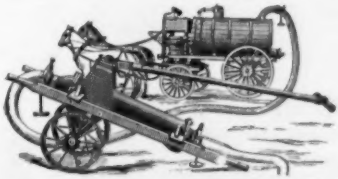

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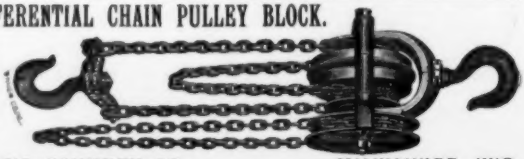

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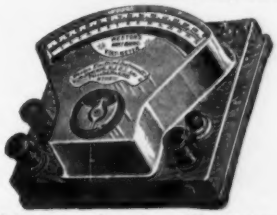

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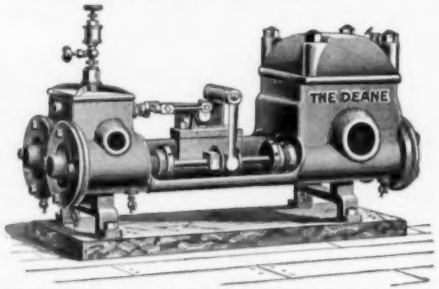

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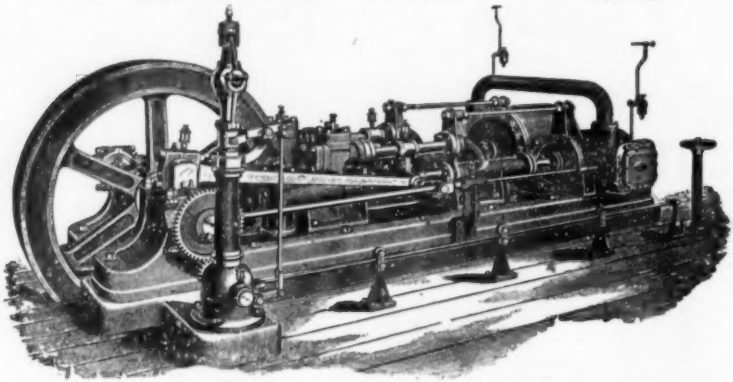

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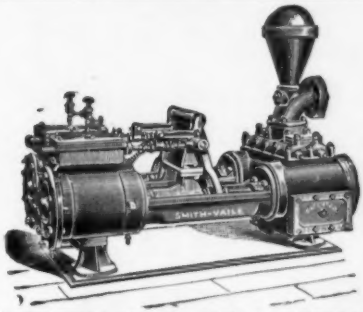

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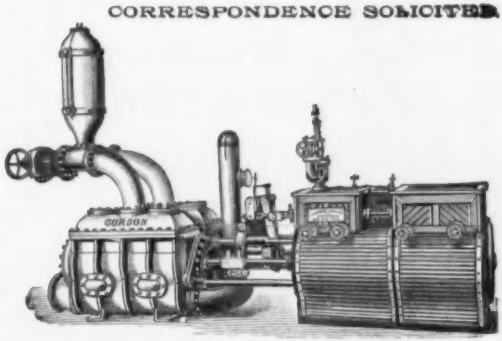

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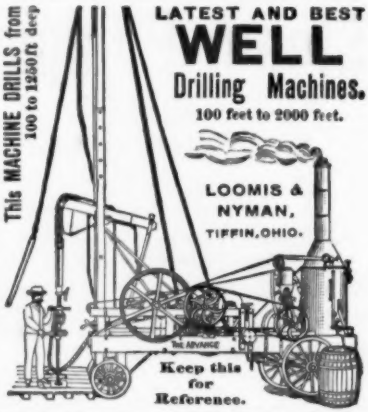

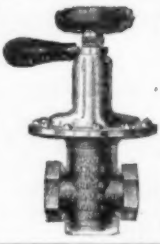

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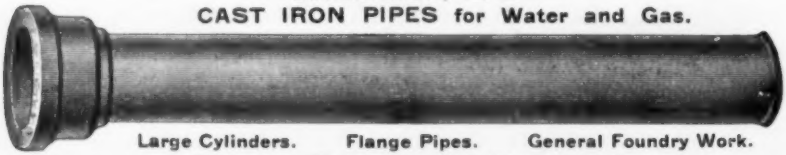

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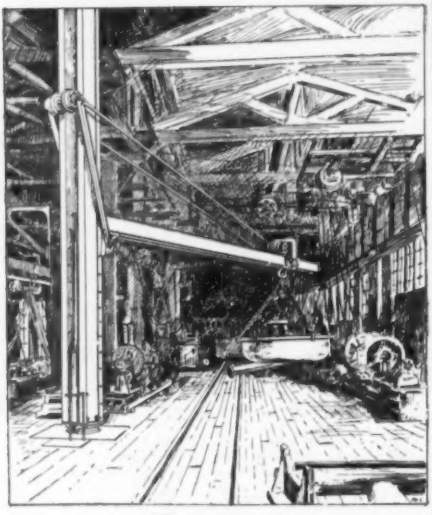

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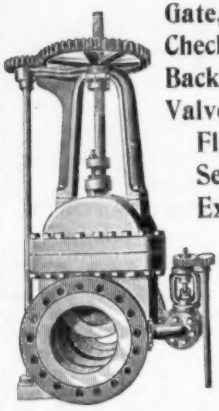

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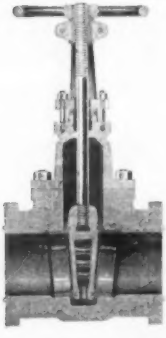

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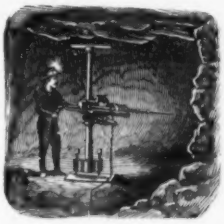

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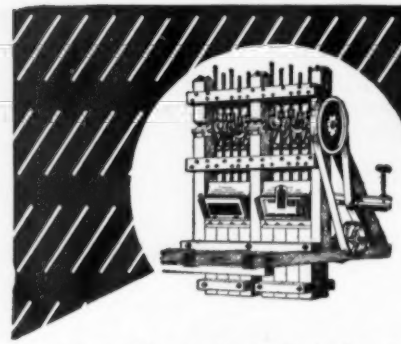

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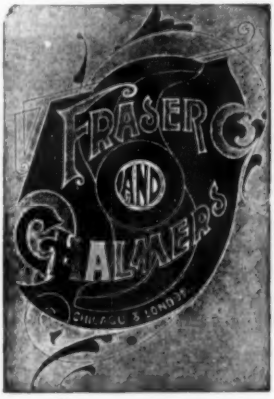

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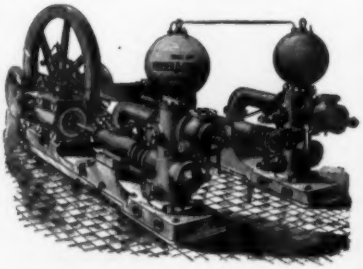

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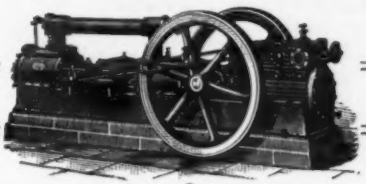

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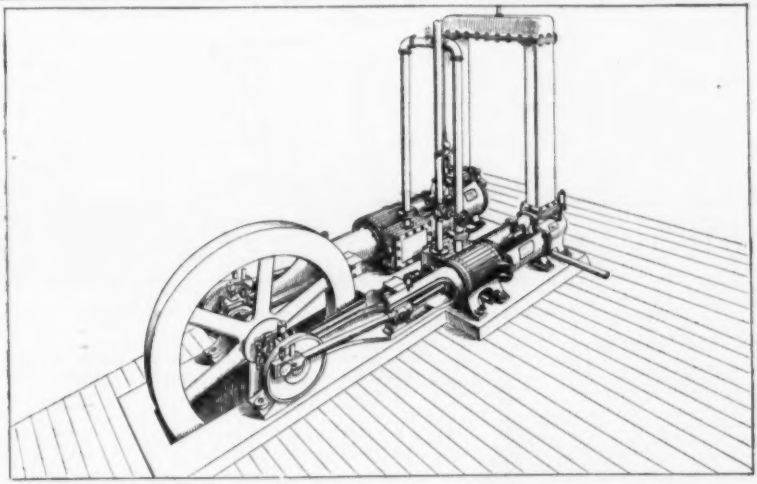

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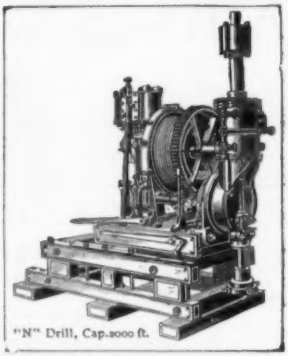

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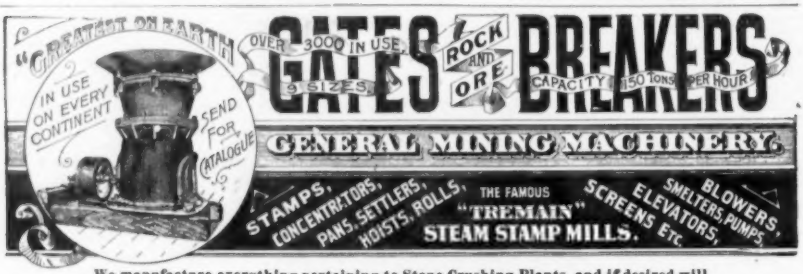

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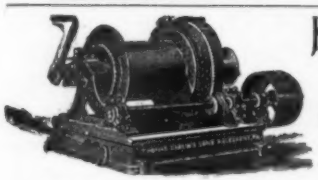

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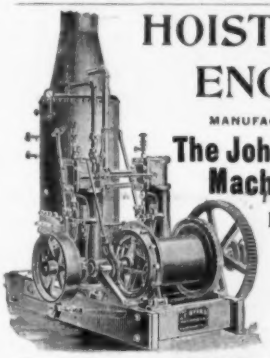

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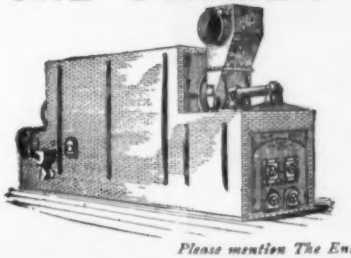

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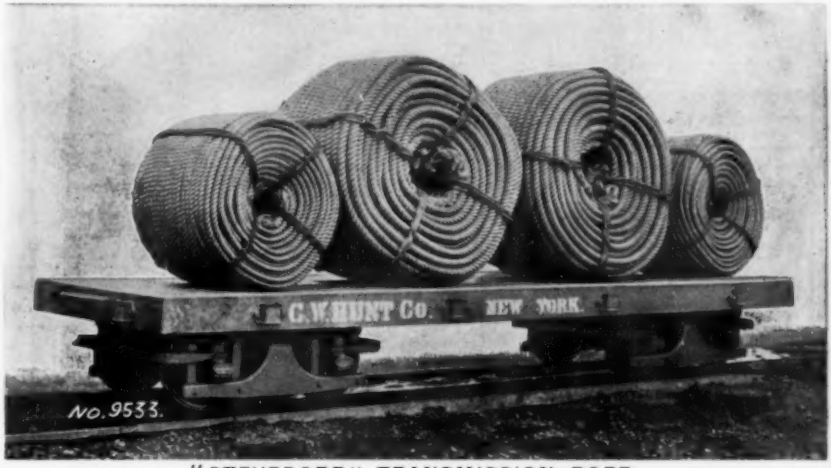

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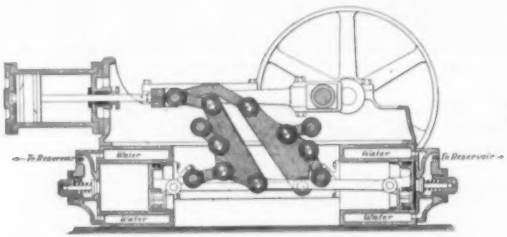

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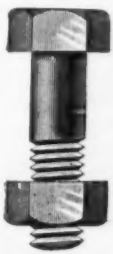

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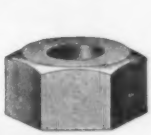

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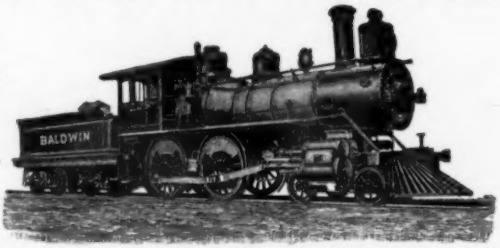

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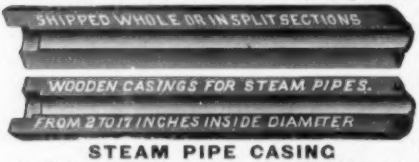

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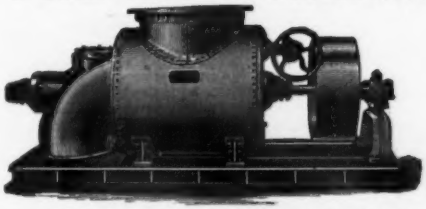

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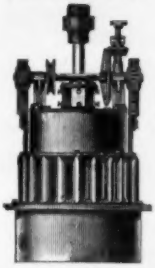

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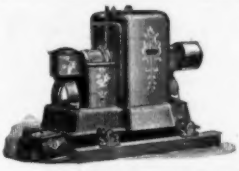

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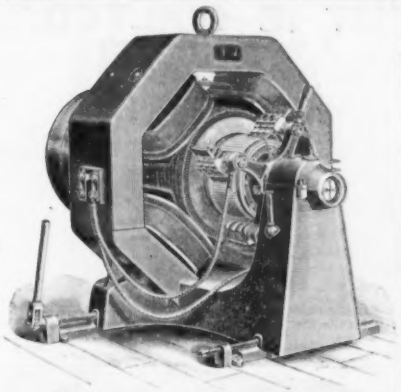

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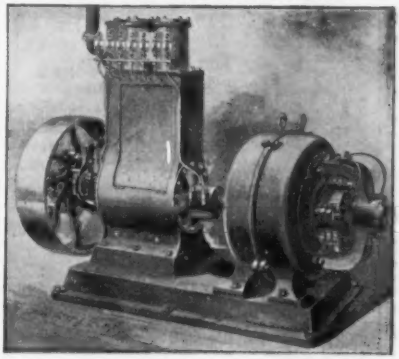

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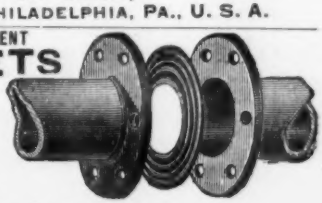

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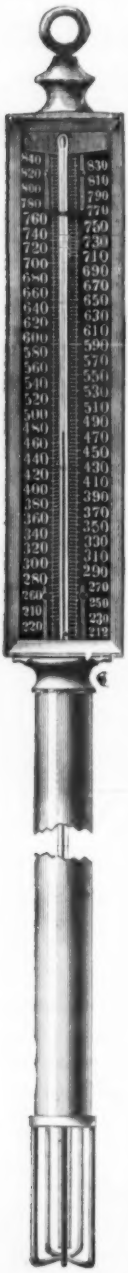

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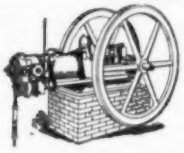

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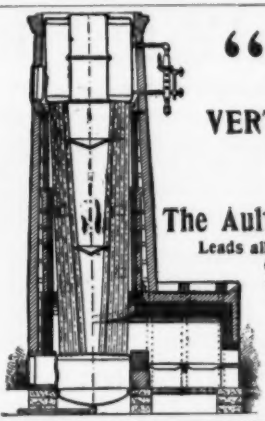

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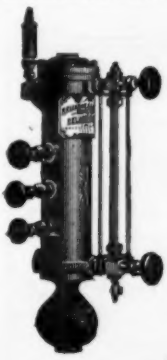

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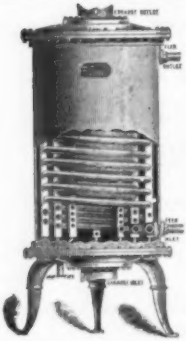

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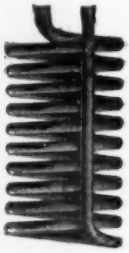

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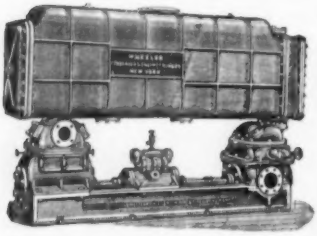

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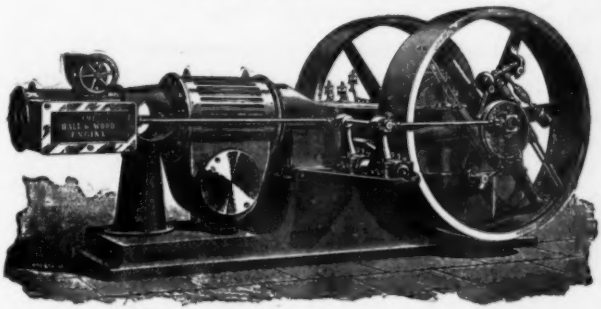

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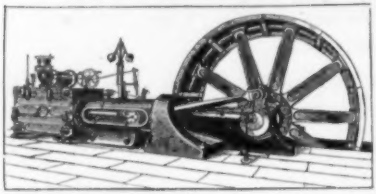

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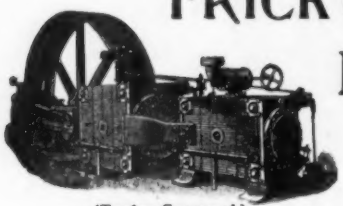

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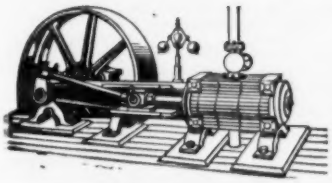

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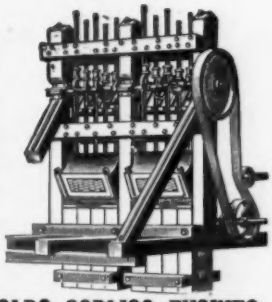

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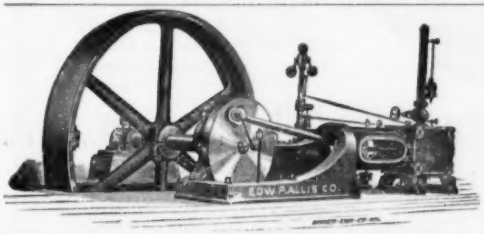

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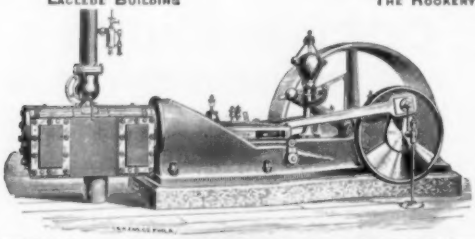

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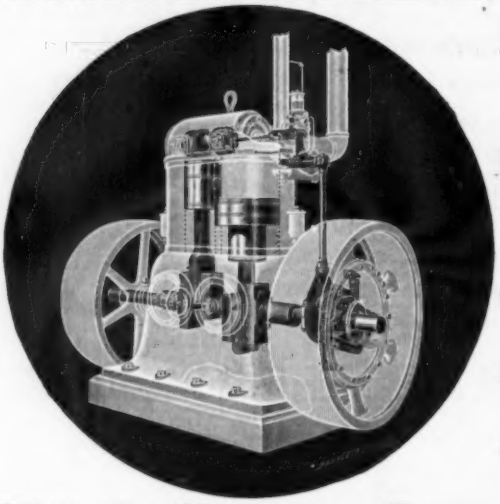

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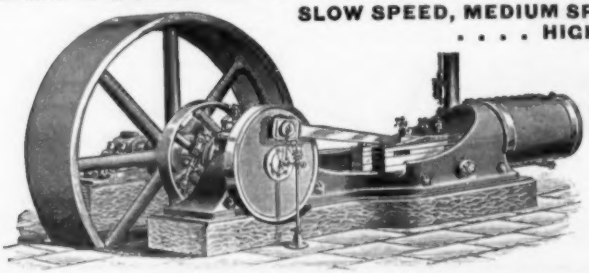

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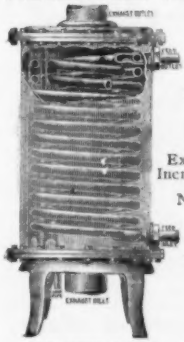

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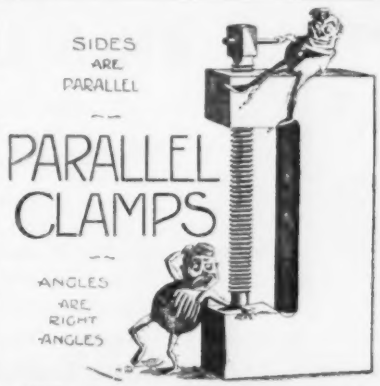

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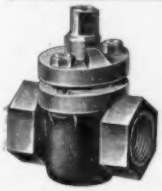

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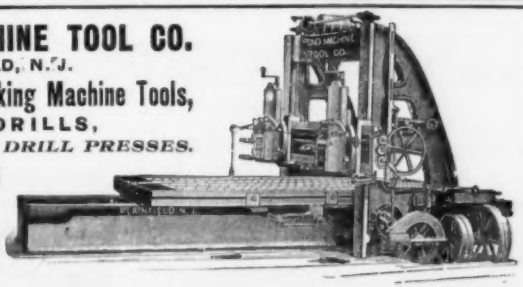

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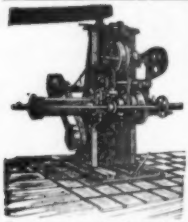

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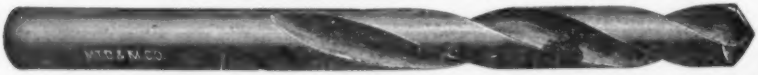

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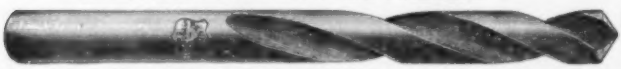

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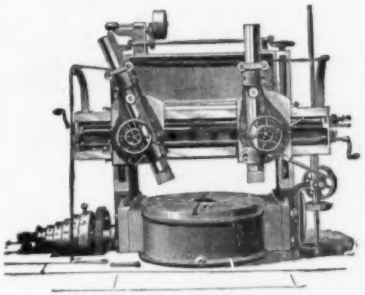

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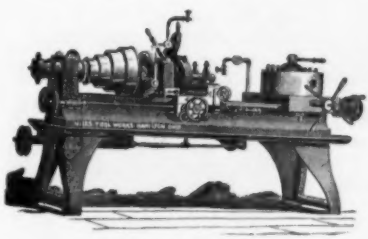

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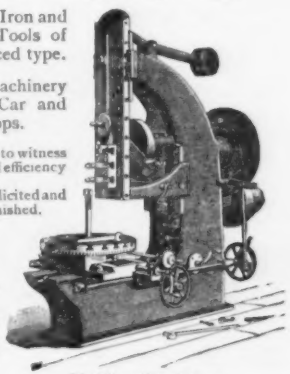

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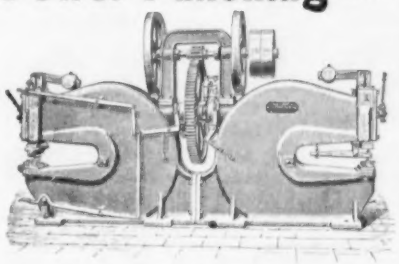

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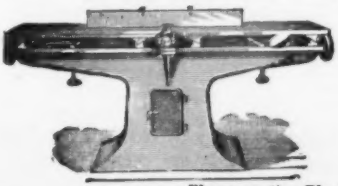

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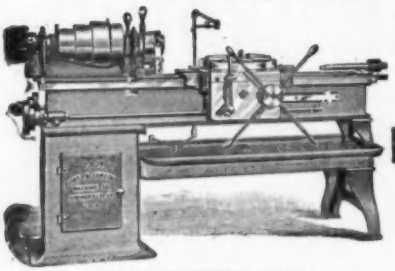

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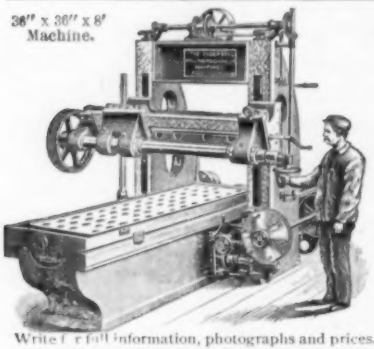

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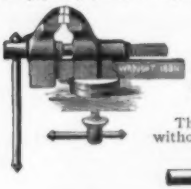

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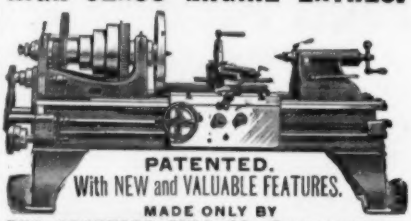

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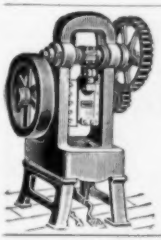

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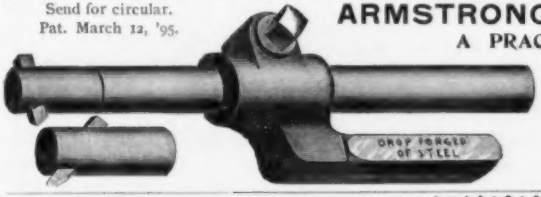

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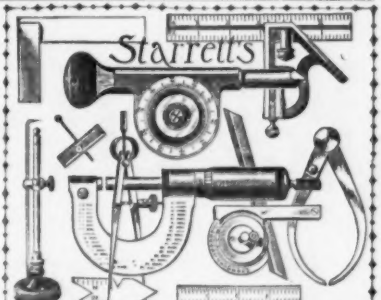

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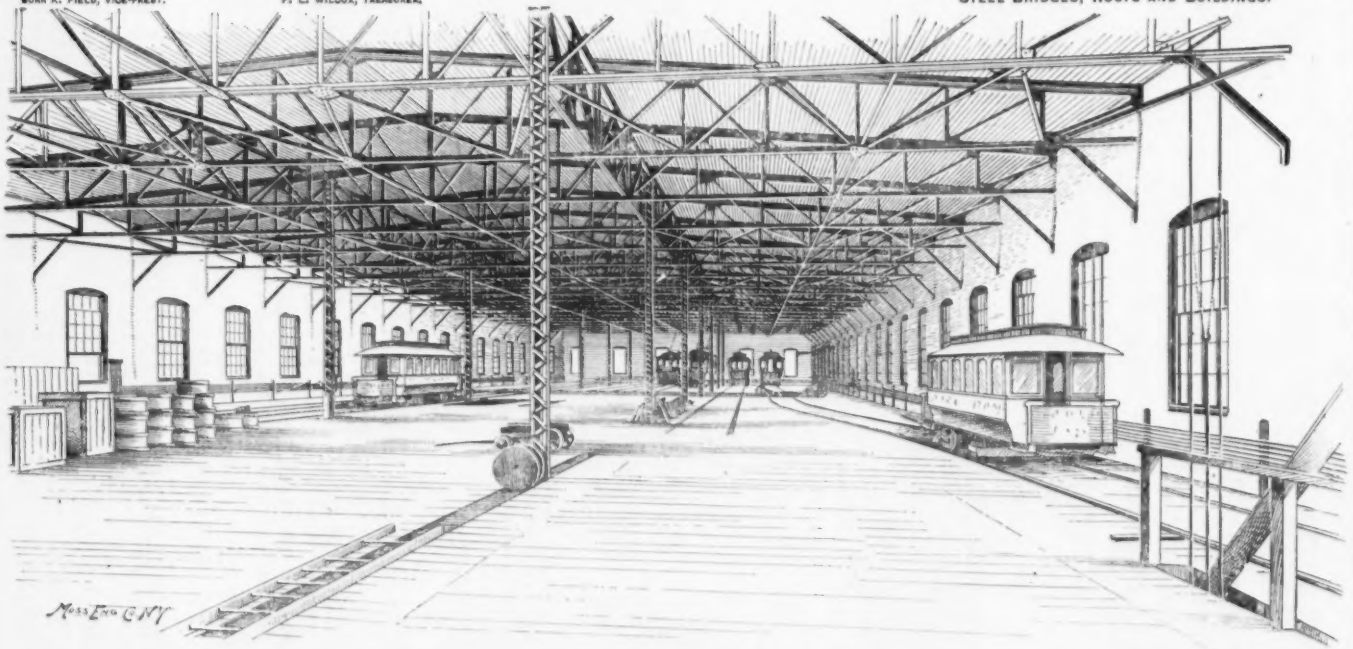

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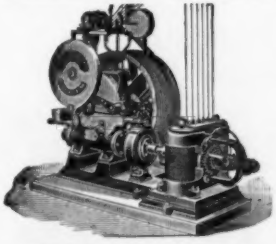

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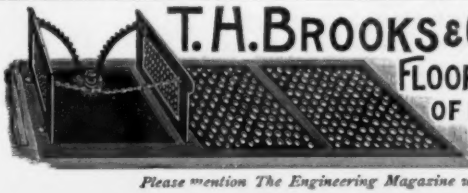

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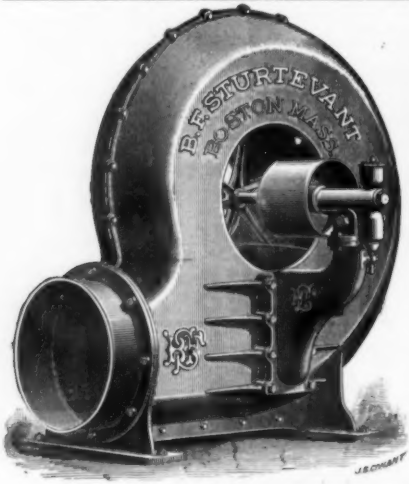

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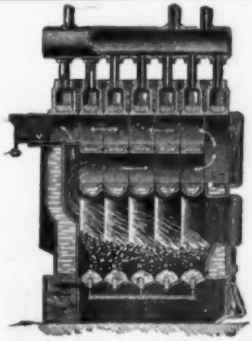

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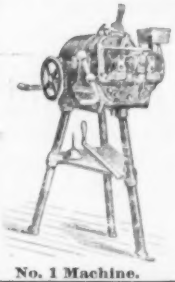

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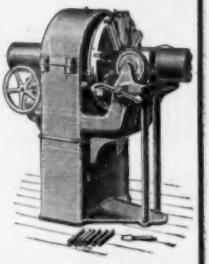

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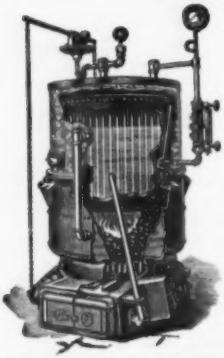

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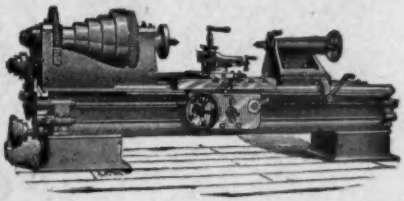

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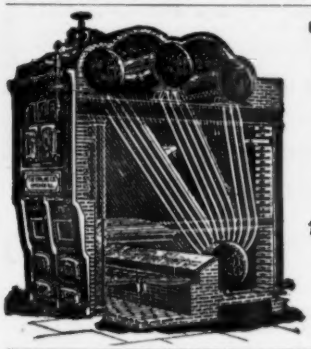

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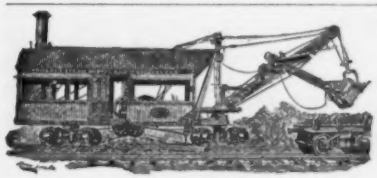

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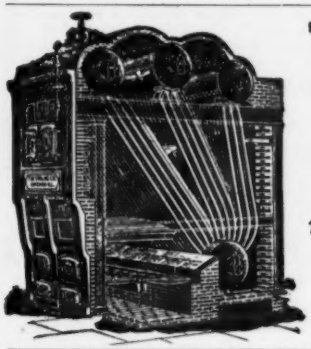

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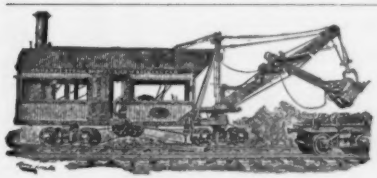

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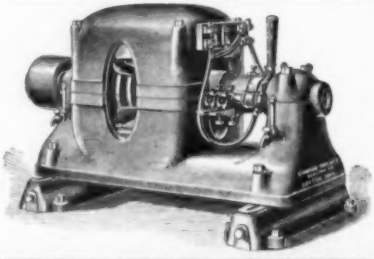

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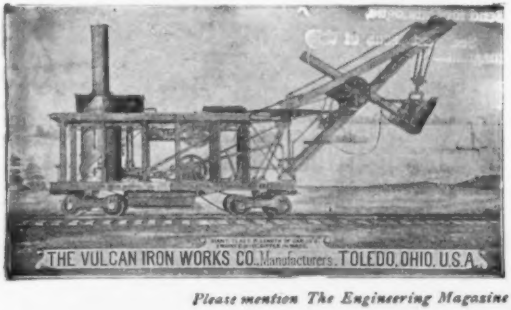

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AUTHORS AND PAPERS THIS MONTH.

ABRAHAM MILLS (*The Currency Problem and its Solution*)=Son of Prof. Mills, an author well known in the scholastic circles of the New York of the past generation; tutored by Prof. Millet of the Columbia Grammar School; since his 21st year has been in active mercantile business in this city and at the same time more or less connected with financial operations. Mr. Mills has naturally studied what he has dealt in, and has frequently been called upon to write for the press upon subjects relating to trade and financial problems. In an article published in *The Evening Post* in the '70's, Mr. Mills advocated a method, which was substantially that used finally to resume specie payments. That article had the honor of calling forth a request of the then chairman of the ways and means committee (Mr. Morrill) to have a number of copies published for distribution among members of the House, which was done. Mr. Mills is a profound thinker and able writer upon financial and commercial questions.

EDWARD ATKINSON (*Taxation in the United States*)=Born at Brookline, Mass.; a student of economics, finance, and commercial polity; has written with authority and influence upon many topics relating to these subjects, and his contributions have appeared in the foremost periodicals in the United States; has given much attention to construction of slow-burning buildings, to factory construction, and insurance; is a pronounced monometallist, and a strong opponent of the silver-policy that some have recently sought to force upon the government. In the present paper, among other things, Mr. Atkinson discusses the profound meaning of the transfer of the paramount control of the production of iron and steel from European States to this country, and shows that the hard times of the last two years have rendered that control more absolute than it would have been otherwise.

H. HEATHCOTE STATHAM, F. R. I. B. A. (*Contemporary English Architects and their Work*)=Has been for many years editor of *The Builder* (London) a leading English architectural weekly, and is therefore in position to be well acquainted with the leading English Architects and their work. Probably the best equipped architectural writer now living. In addition to the engrossing duties of his editorial work, Mr. Statham is in active architectural practice, and is thus enabled to bring to his literary work a true quality of professional sympathy that is rare among writers and critics on architecture. His published works (which show him to be a man of remarkable resource and learning, a critic of keen appreciation, a penetrating thinker, and a writer of great force) include many notable articles in *The Builder*, and important papers read before the architectural societies of England. To his many accomplishments as an editor and an architect, Mr. Statham unites a profound knowledge of music, and a wide reputation as a musical critic. His books include "Architecture for General Readers," "My Thoughts on Music and Musicians," "Form and Design in Music," etc. Mr. Statham's drawings, many of which have been published, show him to be an artist of no ordinary power.

ALEXANDER EWING OUTERBRIDGE, JR. (*The Prevailing Scarcity of Skilled Mechanics*)=Born in Phila., 1850; educated at Episcopal Acad. and by private tutor in chemistry; lectured on physics and taught English branches at Epis. Acad. 1868-9; appointed

assistant in Assay laboratory of U. S. Mint, Philadelphia, 1869; appointed Commissioner to Centennial Exposition, representing Colonies of British Guiana, 1876; invented and tested at U. S. Mint, Phila., an apparatus for saving volatilized bullion, which was fully endorsed and recommended for adoption in official letters of the late Prof. Jas. C. Booth, then "melter and refiner," and the late Wm. E. DuBois, then "Chief Assayer," 1879; transferred to Mint at New Orleans to organize Assay Dept. 1879; resigned from Mint 12 years later to accept position as Metallurgist and Experimentalist at car-wheel works of A. Whitney & Sons, Phila. 1881; appointed member of board of examiners of International Electrical Exposition Phila., 1885; awarded the John Scott Legacy medal and premium by the city of Phila. on recommendation of the Franklin Institute for discovery of process of casting molten metals on carbonized fabrics and obtaining replicas thereof, 1887; resigned from car-wheel works and accepted a similar position at machine toolw orks of Wm. Sellers and Co. Incorp. 1888. Has been a voluminous contributor to scientific and technical publications of first rank and has delivered addresses before numerous learned bodies.

LLEWELYN B. ATKINSON (*The Distribution of Power in Collieries*)=This is a paper read at the recent meeting at Cardiff of the South Wales Institute of Engineers, of which the author is a member. Mr. Atkinson is a prominent mining engineer of long practical experience in the operation of collieries, and his paper has been selected for reproduction in these pages by reason of its practical value and the wide application of the principles for generating and distributing power which he advocates.

SAMUEL WARD STANTON (*Transatlantic Steamships of 1856 to 1880*)=Born January 8, 1870, at Newburgh, N. Y.; youngest son of the late Samuel Stanton, of the shipbuilding firm of Ward, Stanton & Co.; became part owner of the marine paper *Seaboard*, of New York, 1891; awarded medal and diploma at World's Columbian Exposition, Chicago, 1893, for pen drawings of American steam vessels.

GUSTAV LINDENTHAL (*Will a Bridge Across the Hudson River Pay?*)=Is the Chief Engineer of the North River Bridge Company, authorized by Congress to bridge the Hudson at 23d Street in New York across to Hoboken; is a member of the American Society of Civil Engineers, and Canadian Soc. C. E.; member of the Institute of Civil Engineers of Great Britain; Fellow of the American Association for the Advancement of Science, and other scientific organizations. His professional work covers many branches of civil engineering, although he is best known as a bridge specialist.

ALTON D. ADAMS (*The Limits of Electric Power Transmission*)=An electrical engineer, practising in Boston, Mass., and a member of the American Institute of Electrical Engineers.

ARTHUR LAKES (*The Colorado Springs Water Works*)=Born in Martock, Somersetshire, England, in 1843; educated first at Elizabeth College, Guernsey, Channel Islands, and later at Oxford University; thence he went to Canada and later to the United States; at Chicago he met the late Bishop Randall and joined him in planting a church school in Colorado in the pioneer days of 1870; soon he turned his attention to his favorite study of geology and discovered the Atlantosaurus Dinoram, the greatest known land animal; he also contributed many new discoveries in fossil plants to the Hayden Survey; later he was engaged under the United States Geological Survey in the survey of the Leadville region under Mr. S. F. Emmons as artist and assistant geologist; later he accepted the chair of geology at the State School of Mines at Golden, Colorado; he has written many treatises and popular articles on the geology and economic products of Colorado, especially on the coal and metal deposits.

WILLIAM H. CRAFTS (*The Massachusetts Railroad Commission*)=Born 1819; graduated from Harvard, 1840; admitted to the bar, 1843; has contributed articles to some of the leading magazines, and written much for newspapers; author of a technical publication on railroad and other topics; has also done other literary work; secretary of the Massachusetts railroad commission since its establishment in 1869.

Obituary. Franklin Leonard Pope.

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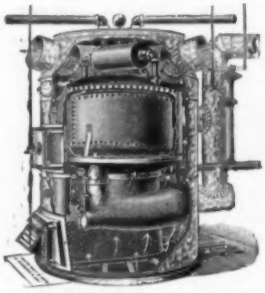

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WATCH PAGE 24.

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Main Belting Co., Philadelphia, Pa.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Belt Lacing.

Bristol Co., Waterbury, Conn.

Blacksmiths' Tools.

Buffalo Forge Co., Buffalo, N. Y.
Merrill Bros., Brooklyn, N. Y.

Blast Furnaces.

Maryland Steel Co., Sparrows Point, Md.

Blowers.

Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Fraser & Chalmers, Chicago, Ill.

Boilers.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Atlantic Works, East Boston, Mass.
Buckeye Engine Co., Salem, Ohio.
H. E. Collins & Co., Pittsburg, Pa.
Continental Iron Works, Brooklyn, N. Y.
Earle C. Bacon, 26 Cortlandt St. N. Y.
Fraser & Chalmers, Chicago, Ill.
The Hazelton Boiler Co., 716 E. 13th St., New York
Heine Safety Boiler Co., St. Louis, Mo.
Maryland Steel Co., Sparrows Point, Md.
Mundy, J. S. Newark, N. J.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Stirling Co., Chicago, Ill.
Robt. Wetherill & Co, Chester, Pa.

Boiler Compound.

Geo. W. Lord, Philadelphia, Pa.

Boiler Fronts and Fittings.

Reliance Gauge Co., Cleveland, Ohio.
Riter & Conley, Pittsburg, Pa.
Vulcan Iron Works, Toledo, Ohio.

Boiler Inspectors.

Hartford S. B. I. & Ins Co., Hartford, Conn.

Boring Machines.

Fitchburg Machine Works, Fitchburg, Mass.

Bolts, Nuts, and Washers.

Milton Mfg. Co., Milton, Pa.

Bricks.

Empire Fire-Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
Pittsburg Terra Cotta Lumber Co, Pittsburg, Pa.

Bridge Builders.

F. C. Austin Mfg. Co., Chicago, Ill.
Berlin Iron Bridge Co., East Berlin, Conn.
The Continental Iron Works, Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Brick and Tile Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co. Columbus, Ohio.

Building Materials.

Berlin Iron Bridge Co., East Berlin, Conn.
T. H. Brooks & Co, Cleveland, Ohio.
Canton Steel Roofing Co., Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
E. B. Moore & Co., Chicago, Ill.
Harrison Bros. & Co., Philadelphia, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
James L. Foote, Slatington, Pa.
Joseph Dixon Crucible Co., Jersey City, N. J.
Empire Fire-Proofing Co., Pittsburgh, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Merchant & Co., Philadelphia, Pa.
Milton Mfg. Co., Milton, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Samuel H. French, & Co., Philadelphia, Pa.
Pittsburg Terra Cotta Lumber Co, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Standard Paint Co, 2 Liberty St., N. Y.
Warren Chemical and Mfg. Co, 27 Fulton St., N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co., Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Cable Railways.

Robert Poole & Son Co., Baltimore, Md.

Cable Railway Driving Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Cables, Electric and Submarine.

Eastern Electric Cable Co., Boston, Mass.

General Electric Co., 44 Broad St., N. Y.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Cableways.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calcining and Drying Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.

Calipers and Dividers.

L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Cameras.

Rochester Optical Co., Rochester, N. Y.

Cams and Tappets.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Carpenters' Tools.

L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Riter & Conley, Pittsburg, Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.

Chemical Works Machinery.

Fraser & Chalmers, Chicago, Ill.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Clay Working Machinery.

W. J. Clark & Co., Salem, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Closets.

Standard Manufacturing Co., Pittsburg, Pa.

Clutches, Friction.

I. S. Mundy, Newark, N. J.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Coal Mining Machinery.

Buffalo Forge Co., Buffalo, N. Y.
W. J. Clark & Co., Salem, Ohio.
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
General Electric Co., 44 Broad St., N. Y.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
J. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Concentrators and Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Sturtevant Mill Co., Boston Mass.

Condensers, Jet.

Deane Steam Pump Co., Holyoke, Mass.

Condensers, Surface.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Consulting Engineers.

Alton D. Adams, Worcester, Mass.
D. Ashworth, Pittsburg, Pa.
Wm. H. Bryan, St. Louis, Mo.
C. M. Conradson, Madison, Wis.
E. L. Corthell 71 Broadway, New York.
Lewis K. Davis, 66 Broadway, New York.
Dr. Willis E. Everette, Tacoma, Wash.
M. Fargusson, Southport, N. C.
Wm. B. Fuller, Boston, Mass.
C. T. Gooding, Tucson, Ariz.
E. B. Hussey, Seattle, Wash.
E. P. Jennings, Ironwood, Mich.
Julian Kennedy, Pittsburg, Pa.
A. L. McRae, Austin, Texas.
Frank Nicholson, Phoenix, Ariz.
Pittsburg Testing Lab'y Ltd., Pittsburg, Pa.
Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
Vandenbergh Lab'y of Chem. Ind., Buffalo, N. Y.
Wm. O. Webber, Boston, Mass.

Contractors' Dump Cars, etc.

Gates Iron Works, Chicago, Ill.
Sheffield Car Co., Three Rivers, Mich.

Contractors' Supplies.

F. C. Austin Mfg. Co., Chicago Ill.
Thomas Carlin's Sons, Allegheny, Pa.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.

Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
W. J. Clark & Co., Salem, Ohio.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link Belt Engineering Co., Phila., Pa.

Copper.

Canadian Copper Co., Cleveland, O.

Corliss Engines.

Edw. P. Allis Co., Milwaukee, Wis.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Merchant & Co., Phila., Pa.
Wheeling Corrugating Co., Wheeling, W. Va.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Crushers, Ore, Phosphate, Rock.

Edw. P. Allis Co., Milwaukee, Wis.
F. C. Austin Mfg. Co., Chicago, Ill.
Bradley Pulverizer Co., Boston, Mass.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Sturtevant Mill Co., Boston, Mass.

Diamond Drills.

M. C. Bullock Mfg. Co., Chicago, Ill.

Fraser & Chalmers, Chicago Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.

Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.
Wm. E. Stieren, Pittsburg, Pa.

Dredging Machines.

W. J. Clark & Co., Salem, Ohio.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

W. F. & J. Barnes Co., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Presses.

Merrill Bros., Brooklyn, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.

Dynamos.

Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Shawhan-Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electric Railway Supplies.

Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Jorporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Morris, Tasker & Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Instruments.

Bristol Co., Waterbury, Conn.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Queen & Co., Inc., Philadelphia, Pa.
Shawhan-Thresher Electric Co., Dayton, O.
Standard Electric Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, Ohio.
United Electric Telephone Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
H. K. Porter & Co., Pittsburg, Pa.

Electrical Rubber Goods.

Home Rubber Co., Trenton, N. J.
Spinney, Virtue & Co., Lynn, Mass.

Electroplating and Electrotyping Machines.

Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Elevators, Steam, Hydraulic, Electric.

M. J. O'Donnell & Co., Cleveland, Ohio.

Emery Wheels.

Manhattan Rubber Mfg Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.

Bignall & Keeler Mfg. Co., St. Louis, Mo.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co,, Philadelphia, Pa.
Wm. E. Stieren, Pittsburg, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petrol um.

Otto Gas Engine Works, Philadelphia, Pa.

Engine Lathes.

Lodge & Davis Machine Tool Co., Cincinnati, Ohio.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Poin

Engines, Stationary.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Southwark Foundry and Machine Co., Phila., Pa
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robert Wetherill & Co., Chester, Penn.

Evaporators.

Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y

Excavators.

Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Expansion Tanks.

Hepe, Koven & Co., 18 Spruce St., N. Y.

Extensible Sewer Brace.

Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng Co., 39 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Files.

Nicholson File Co., Providence, R. I.

Filters.

Continental Filter Co., 44 Wall St., N. Y.
Wheeler Condenser & Eng Co., 39 Cortlandt St., N. Y.

Fire Arms.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Fire Department Equipment.

American Ball Nozzle Co., 837 Broadway, N. Y.

Fireproof Building Material.

Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Empire Fire Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
James L. Foote, Slatington, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Merchant & Co., Philadelphia, Pa.
Milton Mfg. Co., Milton, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co. Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, M
Walker Manufacturing Co., Cleveland, Ohio.

Foot and Hand Presses.

Toledo Machine & Tool Co., Toledo, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.

Forgings.

Milton Mfg. Co., Milton, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.

Furnace Builders.

Fraser & Chalmers, Chicago, Ill,
Julian Kennedy, Pittsburgh, Pa.
Riter & Conley, Pittsburg, Pa.

Furniture.

The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.

C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure, Steam, Water, etc.

Bristol Co., Waterbury, Conn.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Coldwell-Wilcox Co., Newburgh, N. Y.
Continental Iron Works, Brooklyn, N. Y.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.

Gear Cutters.

Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
General Electric Co., 44 Broad St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grading Machines.

F. C. Austin Mfg. Co., Chicago, Ill.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates and Hearths.

Samuel H. French & Co., Philadelphia, Pa.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hand Cars.

Sheffield Car Co., Three Rivers, Mich.

Hangers.

SEE PULLEYS, ETC.

Hardwood Floors.

E. B. Moore & Co., Chicago, Ill.

Hardware Manufacturers.

Charles H. Besly & Co., Chicago, Ill.
Merrill Bros., Brooklyn, N. Y.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Heating and Ventilating Apparatus.

Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Huyett & Smith Mfg. Co., Detroit, Mich.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

American Boiler Co., Chicago, Ill.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
S. Wilks Mfg. Co., Chicago, Ill.
Smith & Anthony Company, Boston, Mass.
United States Heater Co., Detroit, Mich.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio
Webster, Camp & Lane Machine Co., Akron, Ohio.

Hod Hoisting Machinery.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Hollow Bricks.

Empire Fire-Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St., New York.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.

Hydraulic Machinery.

Fraser & Chalmers, Chicago, Ill.
New York Belting & Packing Co., Ltd., New York.
Maryland Steel Co., Sparrows Point, Md
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Queen & Co., Inc., Philadelphia, Pa.

Injectors.

American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.
W. R. Brixey, 203 Broadway, N. Y.
Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
The Okonite Co., Limited, 13 Park Row, N. Y.

Insulating Paper.
Standard Paint Co., 2 Liberty St., N. Y.

Iron Working Machinery.
Charles H. Besly & Co., Chicago, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Merrill Bros., Brooklyn, N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Joists, Iron and Steel.
Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Kyanizing.
Otis Allen & Son, Lowell, Mass.

Lamps, Electric.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Standard Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Lead Corroders.
Harrison Bros. & Co., Philadelphia, Pa.

Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
Pittsburg Locomotive Works Pittsburg, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Thomas Carlin's Sons, Allegheny, Pa.

Locomotive Brakes.
Westinghouse Air Brake Co., Pittsburgh, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Lubricants.
Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.
Sherwood Mfg. Co., Buffalo, N. Y.

Lumber and Shingles.
Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Machine Screws, etc.
Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.
Armstrong Bros. Tool Co., Chicago, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Charles H. Besly & Co., Chicago Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Merrill Bros., Brooklyn, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Mantels.
Samuel H. French & Co., Philadelphia, Pa.

Marine Machinery.
W. A. Crook & Bros Co., Newark, N. J.
Marine Iron Works, Chicago, Ill.

Mathematical Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.
Wm. E. Stieren, Pittsburg, Pa.

Merchant Steel.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Metal Punching and Shearing.
Harrington & King Perforating Co., Chicago, Ill.

Meters, Electric.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.

Meters, Water.
Deane Steam Pump Co., Holyoke, Mass.

Milling Machines.
Ingersoll Milling Machine Co., Rockford, Ill.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.

Mining Machinery.
Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
W. A. Crook & Bros. Co., Newark, N. J.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Mining Screens.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Mortar Colors.
Samuel H. French & Co., Philadelphia, Pa.

Motors, Electric.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Shawhan-Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Nickel.
Canadian Copper Co., Cleveland, O.

Nut Locks.
Eureka Nut Lock Co., Pittsburg, Pa.

Oil Cups.
Sherwood Mfg. Co., Buffalo, N. Y.

Ore Roasting Machinery.
F. D. Cummer & Son Co., Cleveland, Ohio.

Ornamental Iron Work.
Winslow Bros. Co., Chicago, Ill.

Packing
The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Sherwood Mfg. Co., Buffalo, N. Y.

Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Samuel H. French & Co., Philadelphia, Pa.
A. E. Filley Mfg Co., 39 Cortlandt St., N. Y.
Harrison Bros. & Co., Philadelphia, Pa.
Standard Paint Co., 2 Liberty St., N. Y.

Paints (Special for Iron.)
SAME AS ABOVE.

Paper Mill Machinery.
Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Penstocks.
Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds).
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Merchant & Co., Philadelphia, Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.
Rochester Optical Co., Rochester, N. Y.

Pipe, Cast Iron.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
Jeanesville Iron Works, Jeanesville, Pa.
Charles Millar & Son, Utica, New York.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.
National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.
Manville Covering Co., Milwaukee, Wis.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Pipe Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., St. Louis, Mo.

Pipe, Sewer.
Charles Millar & Son, Utica, New York.
Union Sewer Pipe Co., Akron, Ohio.

Pipe, Wrought Iron, Line and Drive.
Crane Company, Chicago, Ill.
Morris, Tasker & Co., Philadelphia Pa.

Planing Mill Machinery.
C. B. Rogers & Co., Norwich, Conn.

Plaster Ornaments.
Samuel H. French & Co., Philadelphia, Pa.

Plating Materials.
Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Portable Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Power Punches and Shears.
Long & Allstatter Co., Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Power Transmission, Electric.
General Electric Co., 44 Broad St., N. Y.

Preservation of Lumber.
Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic.
Maryland Steel Co., Sparrows Point, Md.
Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Pressure Regulators.
Coldwell-Wilcox Co., Newburgh, N. Y.
The Fairbanks Co., New York.
Van Auken Steam Specialty Co., Chicago, Ill.

Prospecting Drills.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulley Lathes.
W. F. & J. Barnes Co., Rockford, Ill.
Fitchburg Machine Works, Fitchburg, Mass.

Pulleys, Shafting and Hangers
Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works, Dayton, Ohio.
Fishkill Landing Machine, Co., Fishkill, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

Pulverizers.
Bradley Pulverizer Co., Boston, Mass.
Fraser & Chalmers, Chicago, Ill.

Pumps and Pumping Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Connersville Blower Co., Connersville, Ind.
Cook Well Co., St. Louis, Mo.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Fraser & Chalmers, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeanesville Iron Works, Jeanesville, Pa.
John H. McGowan Co., Cincinnati, Ohio.
New York Air Brake Co., 66 Broadway, N. Y.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D Wood & Co., Philadelphia, Pa.

Punching and Shearing Presses.
Long & Allstatter Co., Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Quarrying Machinery.
M. C. Bullock Mfg. Co., Chicago, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiator Screens.
Harrington & King Perforating Co., Chicago, Ill.

Radiators.
Crane Company, Chicago, Ill.
H. B. Smith Co., 137 Center St., N. Y.

Railroad Ditchers.
Jeffrey Mfg. Co., Cleveland, O.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Vulcan Iron Works, Toledo, Ohio.

Railroad Ties (All Kinds.)
Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Railway Car Brakes.
Westinghouse Air Brake Co., Pittsburgh, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Railway Feed Wires.
The Okonite Co., Limited, 13 Park Row, N. Y.

Railways, Electric.
General Electric Co., 44 Broad St., N. Y.

Railway Shop Machinery.
Armstrong Mfg. Co., Bridgeport, Conn.
Bradford Mill Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Long & Allstatter Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
The Wright Co., Lowell, Mass.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Railway Specialties.
Carlisle Mfg. Co., Carlisle, Pa.
Eureka Nut Lock Co., Pittsburg, Pa.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
Harrington & King Perforating Co., Chicago, Ill.
Iron City Tool Works, Ltd., Pittsburg, Pa.
Middletown Car Works, Middletown, Pa.
Milton Mfg. Co., Milton, Pa.
New York Air Brake Co., 66 Broadway, N. Y.
H. K. Porter & Co., Pittsburg, Pa.
Sheffield Car Co., Three Rivers, Mich.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railways, Portable.
C. W. Hunt Co., 45 Broadway, N. Y.

Railway Supplies.
Carlisle Mfg. Co., Carlisle, Pa.
Sheffield Car Co., Three Rivers, Mich.

Railway Track Tools.
Iron City Tool Works, Ltd., Pittsburg, Pa.

Range Boilers.
Hepe, Koven & Co., 18 Spruce St., N. Y.

Red Lead.
Harrison Bros. & Co., Philadelphia, Pa.

Reducing Valves.
Ross Valve Co., Troy, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

Refrigerating Machinery.
Frick Company, Waynesboro, Pa.

Road-Making Machinery.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
F. C. Austin Mfg Co., Chicago, Ill.
Harrisburgh F'd'y & Machine W'ks, Harrisburg, Pa.
O. S. Kelly Co., Springfield, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Road Rollers
Addyston Pipe & Steel Co., Cincinnati Ohio.
F. C. Austin Mfg. Co., Chicago, Ill.
Harrisburgh F'd'y & Machine W'ks, Harrisburg, Pa
O. S. Kelly Co., Springfield, Ohio.

Rock Breakers.
Edw. P. Allis Co., Milwaukee, Wis.
F. C. Austin Mfg Co., Chicago, Ill.
Bradley Pulverizer Co., Boston, Mass.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

Rock Drills.
M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Works, 26 Cortlandt St., N. Y
Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 23 Park Place, N Y.
Sullivan Machinery Co., Chicago, Ill.

Rolling Mill Machinery.
Long & Allstatter Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Roofing.
Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio.
A. E. Filley Mfg. Co., 39 Cortlandt St., N. Y.
James L. Foote, Slatington, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Merchant & Co., Philadelphia, Pa.
Ritter & Conley, Pittsburg, Pa
Standard Paint Co., 2 Liberty St., N. Y.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Wheeling Corrugating Co, Wheeling, W. Va.

Roofs, Iron, Truss.
Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.
Maryland Steel Co, Sparrows Point, Md.
Ritter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co, Canton, Ohio.

Rope Transmission.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Phila.

Rubber Goods.
Home Rubber Co., Trenton, N. J.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
N. J. Car Spring & Rubber Co., Jersey City, N. J.
New York Belting & Packing Co., Ltd., New York.
Spinney, Virtue & Co., Lynn, Mass.

Saw Mill Machinery.
Edw. P. Allis Co., Milwaukee, Wis.

Schools.
Cheltenham Academy, Ogontz, Pa.
Correspondence School of Technology, Cleveland, O.
Lawrence Scientific School, Cambridge, Mass.

Scrapers, Wheel and Drag.
F. C. Austin Mfg. Co., Chicago, Ill.

Screens, Mining.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Screen Plates, Punched.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.

Screw Machines.
Bignall & Keeler Mfg. Co., St. Louis, Mo.
Jones & Lamson Mch. Co., Springfield, Vt
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Niles Tool Works, Hamilton, Ohio.

Sectional Coverings.
Manville Covering Co., Milwaukee, Wis.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Separators, Coal and Ore.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.

Sewer Pipe.
Charles Millar & Son, Utica, New York.
Union Sewer Pipe Co., Akron, Ohio,

Shafting.
SEE PULLEYS, ETC.

Sheet Metals.
Hepe, Koven & Co., 18 Spruce St., N. Y.

Sheet Metal Working Machinery.
Toledo Machine & Tool Co., Toledo, Ohio.

Shoes and Dies.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Skylights.
Canton Steel Roofing Co., Canton, Ohio.

Slate.
James L. Foote, Slatington, Pa.

Smokestacks.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

Spark Guards, Perforated.
Harrington & King Perforating Co., Chicago, Ill.

Standpipes.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

Steam and Gas Fitters Tools.
Crane Company, Chicago, Ill.

Steam Regulating Appliances.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Coldwell-Wilcox Co., Newburgh, N. Y.
The Fairbanks Co., New York.
Penberthy Injector Co., Detroit, Mich.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.
Reliance Gauge Co., Cleveland, Ohio.
Ross Valve Co., Troy, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Van Auken Steam Specialty Co, Chicago, Ill.

Steamships and Tow Boats.
Atlantic Works, East Boston, Mass.

Steam Shovels.
Thomas Carlin's Sons, Allegheny, Pa.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Steam Traps.
Buffalo Forge Co., Buffalo, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Van Auken Steam Specialty Co., Chicago, Ill.

Steam Yachts.
Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.

Steel Importers.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Steel Manufacturers.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Steel, Tool.

Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Chrome Steel Works, Brooklyn, N. Y.

Street Sprinklers.

F. C. Austin Mfg. Co., Chicago, Ill.

Street Sweepers.

F. C. Austin Mfg. Co., Chicago, Ill.

Structural Iron Work.

Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Surveying Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N.
Queen & Co., Philadelphia, Pa.
Wm. E. Stieren, Pittsburg, Pa.

Tanks, Iron.

Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Continental Iron Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
S. Wilks Mfg. Co., Chicago, Ill.

Tanks, Wood.

Williams Mfg. Co., Kalamazoo, Mich.

Telegraph Wires and Cables.

General Electric Co., 44 Broad St., N. Y.
Eastern Electric Cable Co., Boston, Mass.
John A. Roebling's Sons Co., Trenton, N. J.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Telephones.

United Electric Telephone Co., New York.

Testing Machinery.

Wm. Sellers & Co., Philadelphia, Pa.

Thermometers.

Bristol Co., Waterbury, Conn.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.
Queen & Co., Inc., Philadelphia, Pa.

Tiles.

Merchant & Co., Philadelphia, Pa.
Samuel H. French & Co., Philadelphia, Pa.

Tin.

Gummey, McFarland & Co., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Merchant & Co., Philadelphia, Pa.
Wheeling Corrugating Co., Wheeling, W. Va.

Tin Plate Rolling Machinery.

Robert Poole & Son Co., Baltimore, Md.

Track Bolts.

Milton Mfg. Co., Milton, Pa.

Tramways.

Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.

Tramways, Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Fraser & Chalmers, Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
C. W. Hunt Co., 45 Broadway, N. Y.

Transmission Machinery.

Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill Co., Chester, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.

Tube Scrapers.

Sherwood Mfg. Co., Buffalo, N. Y.

Turbines.

Dayton Globe Iron Works, Dayton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
R. D. Wood, & Co., Philadelphia, Pa.

Turn Tables.

Wm. Sellers & Co., Philadelphia, Pa.

Twist Drills.

Standard Tool Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mch. Co., New Bedford, Mass.

Vacuum Pumps.

A. S. Cameron, Steam Pump Works, E. 23d St., N. Y.
Clayton Air Compressor Works, 26 Cortlandt St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.

Valves, Gas, Steam, and Water.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Coldwell-Wilcox Co., Newburgh, N. Y.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Jeanesville Iron Works, Jeanesville, Pa.
Ross Valve Co., Troy, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Standard Thermometer Co., Peabody, Mass.
Van Auken Steam Specialty Co., Chicago, Ill.

Ventilating Appliances.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Globe Ventilator Co., Troy, N. Y.
B. F. Sturtevant Co., Boston, Mass.
Merchant & Co., Philadelphia, Pa.

Vises.

Bignall & Keeler Mfg. Co., St. Louis, Mo.
Merrill Bros., Brooklyn, N. Y.

Voltmeters.

Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Weston Electrical Ins. Co., Newark, N. J.

Water Works Supplies.

American Well Works, Aurora, Ill.
Coldwell-Wilcox Co., Newburgh, N. Y.
Cook Well Co., St. Louis, Mo.
The Fairbanks Co., New York.
McNeal Pipe and Foundry Co., Burlington, N. J.
Charles Millar & Son, Utica, New York.

Water Wheels.

Dayton Globe Iron Works, Dayton, Ohio
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Well Sinking Machinery.

American Well Works, Aurora, Ill.
Cook Well Co., St. Louis, Mo.
Loomis & Nyman, Tiffin, Ohio.

White Lead.

Samuel H. French & Co., Philadelphia, Pa.
Harrison Bros. & Co., Philadelphia, Pa.

Window Guards (Jail Work.)

Harrington & King Perforating Co., Chicago, Ill.

Wire.

Charles H. Besly & Co., Chicago, Ill.
Merchant & Co., Philadelphia, Pa.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Cloth.

Fraser & Chalmers, Chicago, Ill.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
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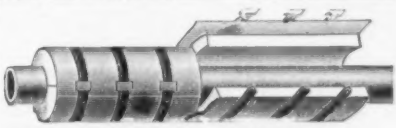

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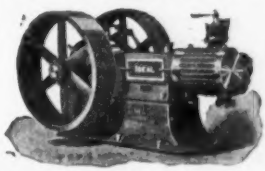

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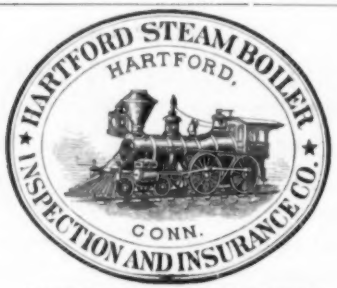

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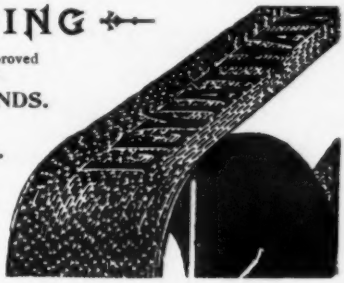

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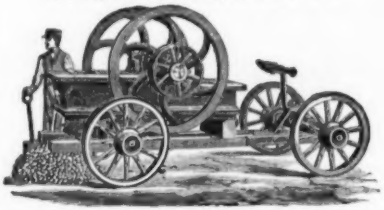

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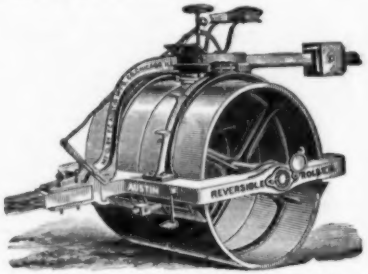

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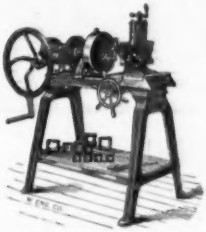

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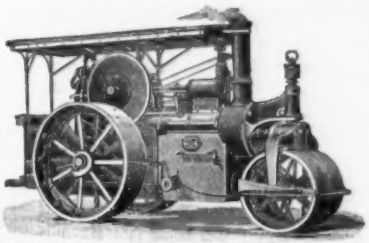

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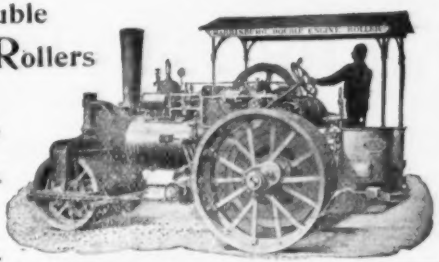

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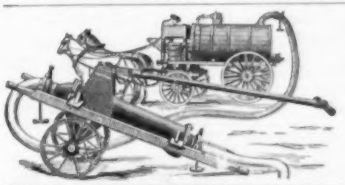

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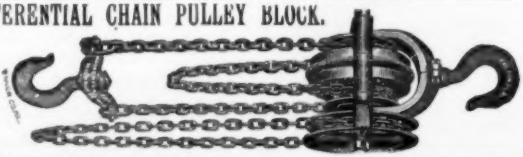

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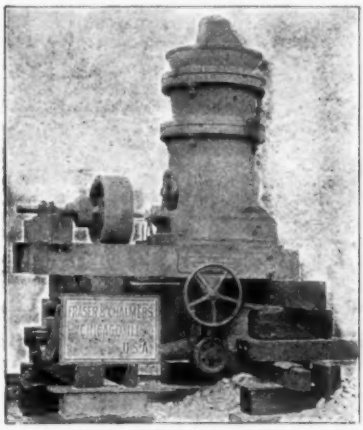
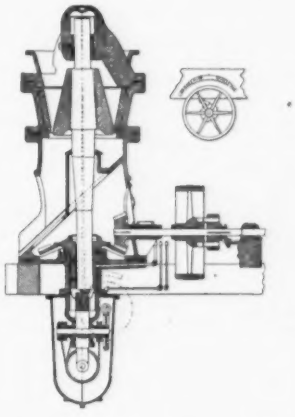
The Comet Crusher.

THIS crusher, which has won for itself the reputation of being a most efficient machine, is manufactured by Fraser and Chalmers, Chicago, U. S. A. and London, England, with branch offices in New York, City of Mexico, Denver, Colorado, Salt Lake City, Utah, and Helena, Montana.

The exterior and interior view of this crusher herewith presented show it to be of the gyratory type. It gives a great capacity with a small expenditure of power. It is, also, more self-contained as to strains than is the ordinary jaw crusher, and has an advantageous cubing or cross-breaking action upon the material treated. Among numerous mines and quarries supplied with these crushers by the manufacturers, thirteen have been furnished to the De Beers Diamond Mines, South Africa, for crushing hard blue diamondiferous rock. The new adjustable gear is found to work easily and instantly while running, and is carefully designed to be secure against occasion of breakage or trouble, while of great convenience, especially in providing different sizes of macadam or ballast by use of one machine.



When the spindle is lowered coarse rock seen on the pile to the right is crushed; when the spindle is raised fine material shown on the pile to the left is crushed. Turning the hand wheel from left to right will raise the spindle and crush fine; turning the hand wheel from right to left will lower the spindle and crush coarse. A ratchet and pawl are provided immediately behind the wheel, which prevents the hand wheel from moving on account of jar. Two sheaves are mounted on the end of a vertical moving ram to carry a chain for raising and lowering the ram.



This ram has a slot so as to allow the worm-wheel shaft to work freely through it. At the upper end of the ram is a brass cup-shaped bowl which is filled with oil. This cup moves up and down with the ram, carrying the oil with it. On the end of the ram are the ordinary button and toe on which the spindle rests. In lowering the ram the spindle follows it in passing through the driving bevel gear, also the upper end passes through the upper bearing in the tripod.

Not only is this crusher thoroughly adjustable to produce varying product, but it will also accommodate any amount of wear when the same sized product is required. The mechanism for

raising and lowering the spindle is so constructed that it is not necessary to stop the crusher to make the adjustment. By making the upper bearing a fixture, the bevel driving gear also being a fixture, the distance between these two bearings remains the same, and the spindle sliding through them maintains its angle irrespective of the various positions in its height.

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THIS pumping engine is of the rotative, horizontal, fly-wheel type, with three steam cylinders side by side, arranged compound, each steam piston operating a single acting horizontal plunger pump, the water end consisting of three equal, single-acting plunger pumps, side by side, in direct line with, and directly connected to the steam ends. The movement is transferred to the crank shaft by means of steel beams, connected to crossheads by links and to the crank shaft by connecting rods.

The high-pressure steam cylinder is 13" and the two low-pressure steam cylinders 20" in diameter, each 24" stroke. Each steam cylinder has four Corliss valves. The low-pressure steam cylinder valves are horizontal, and have a fixed cut-off of half stroke without a releasing gear, but are otherwise of the Corliss style. The valves derive their motion from one common wrist-plate, directly connected to eccentric on crank shaft. The high-pressure steam cylinder has four valves placed vertically, with all their moving parts, such as links, wrist-plate, &c., on top of the cylinder, with releasing gear, and horizontal dash pots arranged with a variable cut-off. All four valves derive their motion from one wrist-plate, connected through a lever to an eccentric on the crank shaft. A receiver is placed between the high and low-pressure steam cylinders below the floor, and fitted with a re-heating coil.

The steam pistons have bolts for carrying their weight. The piston rods are of steel 2¾" diameter secured to the piston by a slight taper and nut, and to the crosshead by a key. The crossheads are made of cast steel, with brass shoes. The links between crosshead and engine beam are forged, and have adjustable brass boxes. The engine beams are of cast steel with pins for crosshead links shrunk and riveted in place. A beam shaft extends on both sides of the beam for bearings, and is secured to the beam by driving fit and keys.

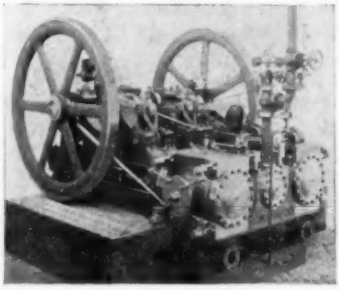
The crank shaft is one solid forging with cranks cut out, and the three cranks are set at angles of one hundred and twenty degrees. The crank-shaft is 7" diameter with crank pins 7" diameter and 5" long. The total length of the crank shaft is 9' 10".

The three engine frames are of cast iron, and the pump barrels are bolted to same bed-plate.

The three crosshead slides are of cast iron.

The high-pressure engine frame and the low-pressure engine frames are made without bearings for the crank shaft, but the high-pressure frame is bolted securely to the two outside low-pressure frames.

The crank shaft bearings have adjustable babitted quarter boxes. The engine beam bearings, six in number, also have adjustable, solid babitted,



HIGH DUTY PUMPING ENGINE.

brass quarter boxes. The fly wheels are 8' in diameter, keyed to the crank shaft outside of the bearings.

A speed governor limits the revolutions to 80 per minute. The engine has a by-pass steam valve (for admitting live steam direct into the receiver for low-pressure cylinders) operated from a check valve on the discharge pipe, in such a manner that it will be open when the pump is at rest, or the check valve is closed ; and it will be shut when the pump is in motion or the check valve is open, thus working automatically with the pump. This arrangement renders the engine automatic both in starting and working, and only dependent upon such apparatus as may be used for keeping up a steady supply of water at a steady pressure.

The pump end consists of three single-acting plunger pumps, with solid steel plungers 4 $\frac{5}{16}$" diameter, 24" stroke, and directly connected with the steam end by the crosshead connecting ends of piston rods and pump plungers.

The pump barrels are of brass, with openings and grooved flanges for suction and discharge valve chambers, and with stuffing boxes for plungers. Each pump barrel has one suction and

one brass discharge valve chamber containing seven valves 2½" diameter, the effective valve area being of 200%.

The suction and discharge piping are of cast iron connected into a suction pipe and into a main discharge pipe each, 6" diameter. A 6" check valve is fitted to the top of the discharge pipe.

The capacity of this pumping engine at 80 revolutions is 358 gallons per minute, and, with steam pressure at 125 lbs. per square inch, it will work against a water pressure of 750 lbs. per square inch. The engine consumes 25 lbs. of water per h. p. working at a speed of 60 revolutions per minute.

This high duty pump was installed by the Laidlaw–Dunn–Gordon Pump Co., of Cincinnati, Ohio, in the Cupples Building, St. Louis, for the purpose of driving fifty-two hydraulic elevators at a cost of seven cents each per day.

A Large Order.

A LARGE and important order for air-compressing machinery for running rock-drills, engines, pumps, and other machinery has been recently placed with the Ingersoll-Sergeant Drill Company, 26 Cortlandt Street, New York. The contract for the construction of the Jerome park reservoir, which is to be added to the water works of New York, having been awarded to Mr. J. B. McDonald at $5,473,060, involving the removal of more than 3,000,000 cu. yds. of rock, the question of power for driving machinery for the execution of the contract was one of such importance that the contractor thoroughly investigated the subject of direct steam driving as contrasted with distribution of power by compressed air from a central station, wisely deciding in favor of the latter.

For this purpose he ordered the entire plant from the company named, comprising compound condensing Corliss air compressors run by high-class boilers transmitting and distributing compressed air at 80 pounds pressure throughout the work.

It is contemplated to use a battery of several Air Compressors placed side by side, the unit adopted being a Duplex Compressor with steam cylinders 24" and 44" in diameter, stroke 48", driving two Piston Inlet Air Cylinders each 24¼" in diameter by 48" stroke. The capacity in free air of this machine is between 3000 and 4000 cubic feet per minute. This is a duplicate of Compressors at work at the Anaconda mines in Montana, where very economical results have been derived.

A $1500 Lathe Given Away.

THE Lodge and Davis Machine Tool Co., of Cincinnati, Ohio, announce that on March 1, 1896, they will present to the technical or mechanical school receiving the greatest number of votes a magnificent nickel and gold-plated 16-inch swing tool-room lathe. This lathe was exhibited by the firm named at the World's Fair in Chicago, and was considered to be among the finest exhibits in Machinery Hall. The entire lathe is nickel plated, with the exception of the bolts, which are gold plated. The inside of the bed is finished in white enamel. The cabinets are provided with shelves, which are lined with cardinal silk plush. The cost of this lathe, as regularly built, is $450, and the extra work in preparing, plating, etc., amounted to $1100.

It is not only "a thing of beauty," but in addition is a tool-room lathe, designed and built with reference to the highest standard of mechanical requirements, and ready to be set up and run. A circular describing the lathe in detail may be obtained from the manufacturers. Any one in the United States may vote in conformity with the following conditions:

(1) Full name and address must be given. (2) Give name of Technical School preferred. (3) No duplicate votes will be registered. (4) No votes will be registered that are received after 12 noon of March 1, 1896.

A Big Slate Train.

As indicating the enormous growth of the roofing slate industry in Pennsylvania, the following extract from the *Bethlehem Times* (Aug. 19) is interesting. "On Saturday, August 17, the largest shipment of roofing slate ever made in America, a solid train of thirty-seven cars, was made by the Slatington-Bangor Slate Syndicate from Bangor and Slatington, Pa., via the Central Railroad of New Jersey and the Philadelphia & Reading through the Central States Dispatch. The train was 1380 feet long and was drawn by two powerful engines. The total weight of the slate was 1,020,000 pounds or nearly 2000 squares."

At East Penn. Junction, at Allentown, the train was made up and gaily decorated. It was then hauled to the Gordon Street station and photographed. It left there an hour later for the west, running intact over the Philadelphia & Reading, Baltimore & Ohio, and Big Four routes, distributing its consignment, thirty-seven cars of roofing slate, to points in ten states, viz., Virginia, West Virginia, Ohio, Kentucky, Indiana, Illinois, Missouri, Iowa, Wisconsin, and Minne-

sota. The roofing slate in this enormous consignment is claimed to be the best quarried in the United States.

A Giant Digger—The Vulcan Special Trench Steam Shovel.

THIS design of Trench and Sewer steam shovel appears to be novel, though the car frame and means of self-propulsion are quite similar to the "Little Giant" steam shovel, of the same manufacturers (The Vulcan Iron Works Co. of Toledo, Ohio). The crane, as is well indicated in the engraving, is a massive structure, but this massiveness is necessary to accomplish what is required of it, for while the manufacturers have never guaranteed the shovel to excavate more than 600 cu. yds. of loose material in ten hours from a trench from 4 to 8 ft. wide, and from 1 to 12 feet deep, it can readily dig 20 ft. deep if desired. The crane will dump excavated material either right or left from the mast and 10 ft.

high from the ground on which the shovel stands. A notable feature is that it continually stands on solid ground, moving backwards, or away from the trench, as it digs; thus doing away with the danger of caving in of the trench sides. The several new devices are thoroughly covered by patents.

We learn from the *Pittsburgh Dispatch*, that this machine is now at work on the largest conduit and the largest crib excavation in the country, advancing, to the wonder of all who witness its operation, at the rate of 750 ft. per day. The giant digger weighs between 50 and 60 tons. It requires ten men to operate it. When running it averages 25 to 30 ft. per hour for a trench 10 ft. wide at top, 7 ft. wide at bottom and 12 ft. deep, removing 1¼ yards at each dipper full. A recent letter from the engineer running the shovel says, 4 foremen with 150 men were 5 days doing what the shovel did in 2 days.

The manufacturers gave a modest guarantee of 400 cu. yds. on this shovel, as a day's work, but it has done over 1100 yds. in 12 consecutive hours.

The Ball Nozzle.

THE rapidity with which the introduction of this invention has progressed is quite phenomenal. After repeated demonstrations of its efficiency at great fires in various parts of the country and in New York city the fire commissioners of New York have adopted the device, and henceforth it will be a part of the regular fire department equipment. The *New York Tribune* explains that this action was taken after there had been repeated tests of the nozzle, and Chief Bonner had reported that he had tried it thoroughly. For several months the firemen have been using the nozzle in experiments at fires in the city, and Chief Bonner is satisfied that its value has been demonstrated beyond question.

The Chief has reported that Clarendon Hall was saved from destruction by the timely use of the ball nozzle. The fire in this case was in the air chamber; firemen tried to enter through the trap-door with a straight stream of water, but the flames were so fierce that entrance was out of the question, when the ball nozzle was brought into play and the single hoseman using the ball nozzle spray made instant entrance and in a few moments conquered a fire that would otherwise have proved very disastrous.

The energy of the American Ball Nozzle Company, 897 Broadway, New York, has doubtless been one of the causes of the rapid growth in favor which the public entertains for this improvement, but the most potent cause is the fact that its merits justify fully all claims made for it.

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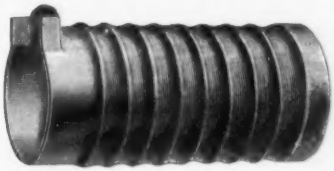

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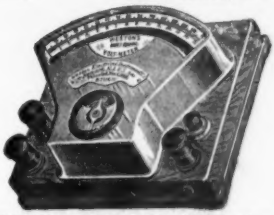

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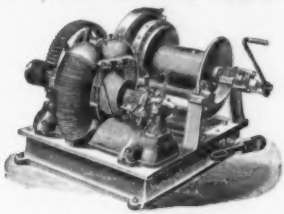

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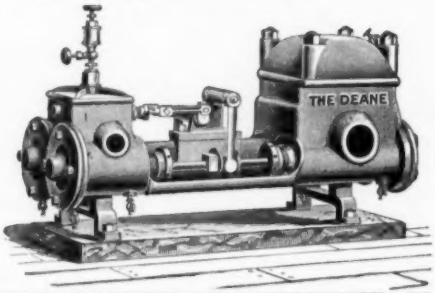

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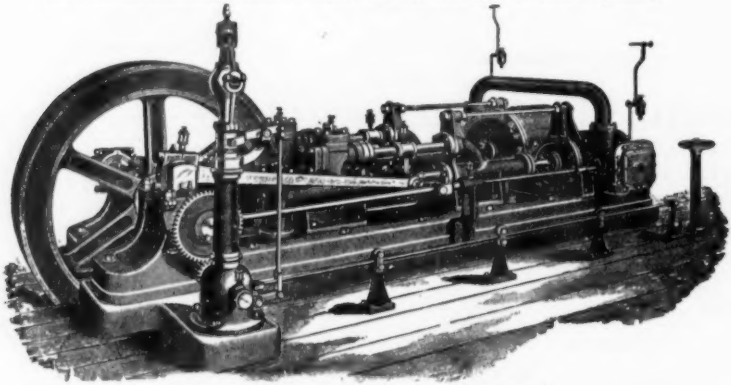

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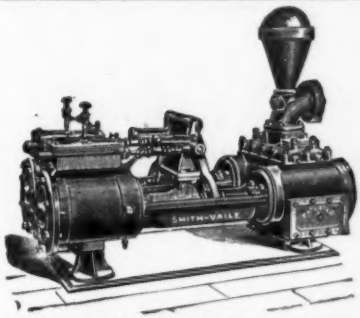

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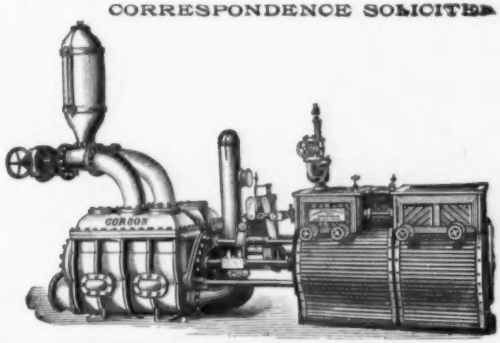

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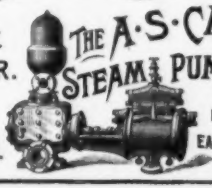

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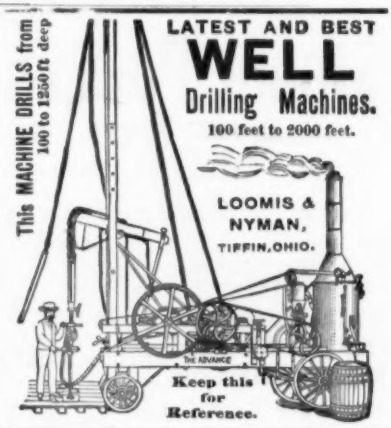

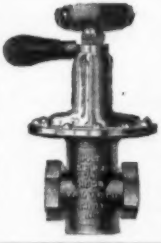

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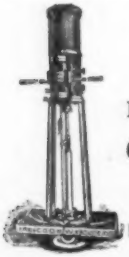

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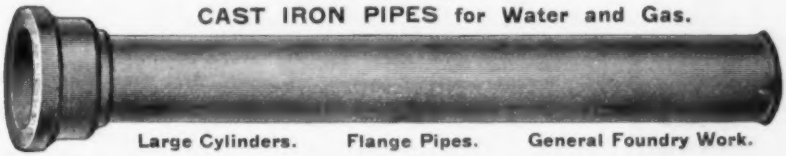

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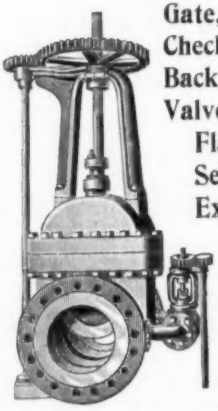

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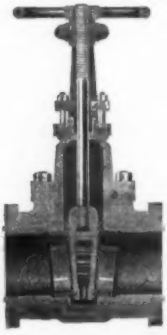

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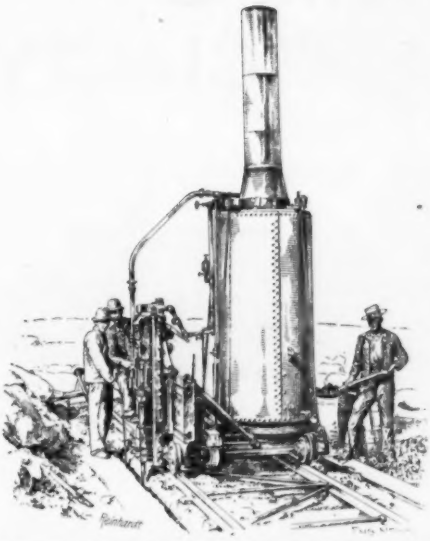

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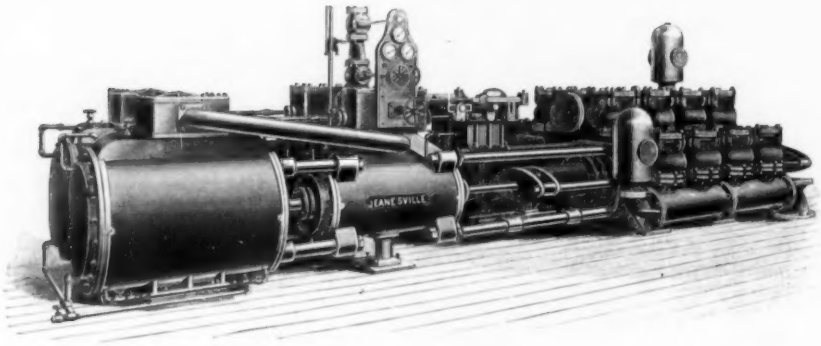

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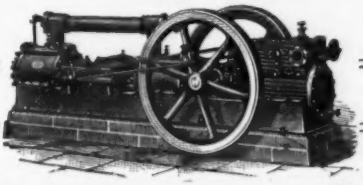

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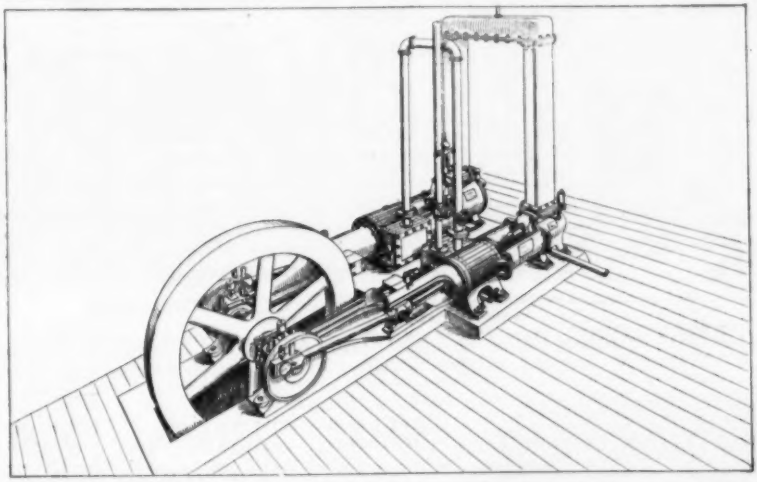

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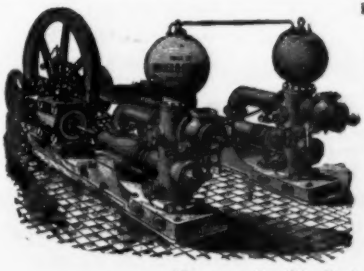

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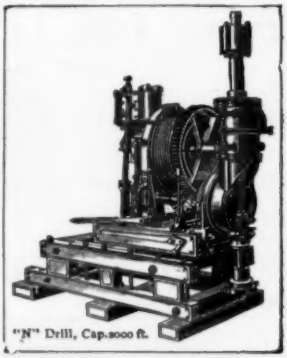

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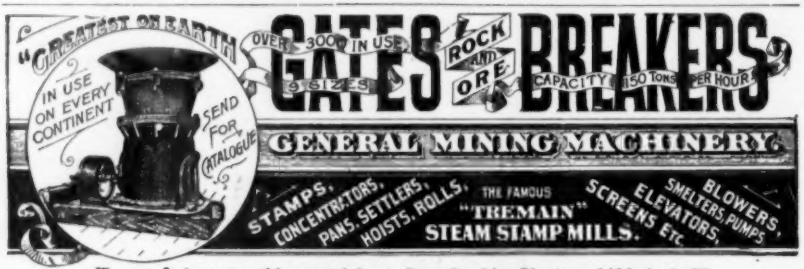

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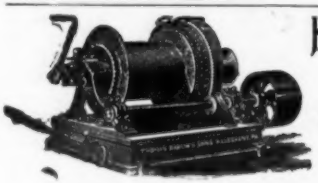

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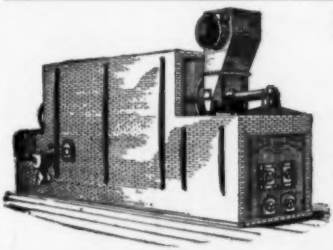

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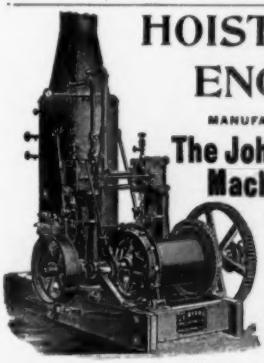

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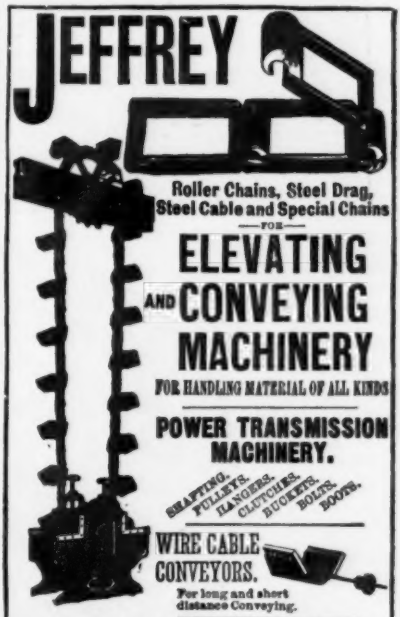

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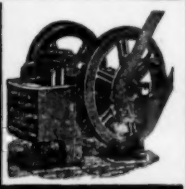
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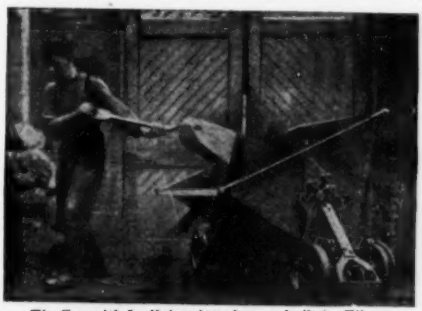

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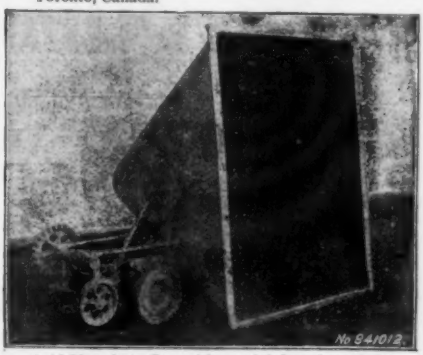

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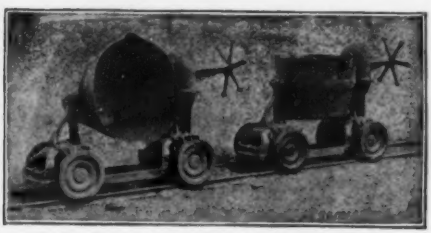

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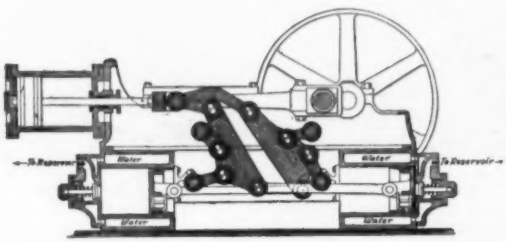

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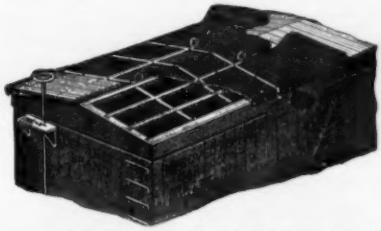

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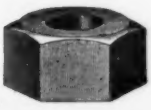

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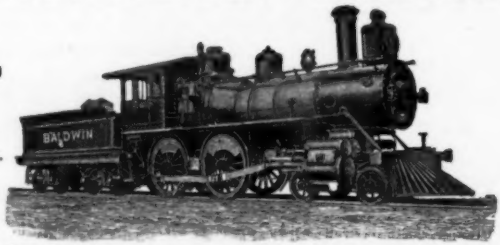

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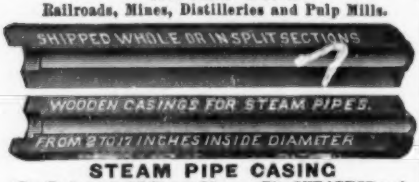

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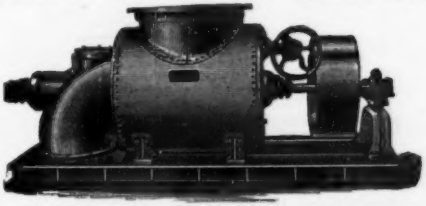

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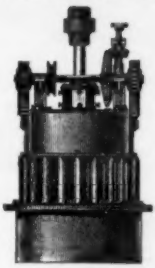

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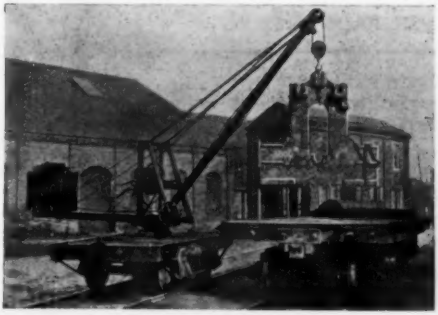

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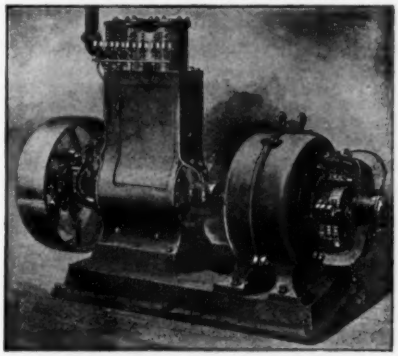

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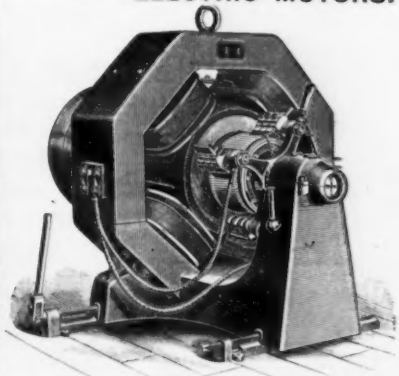

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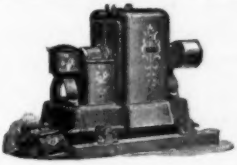

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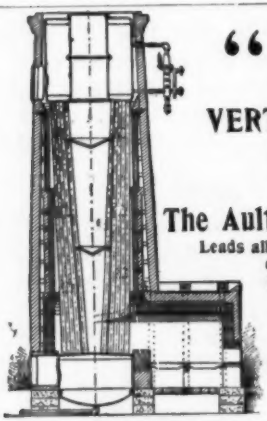

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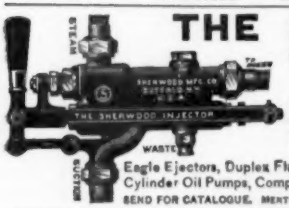

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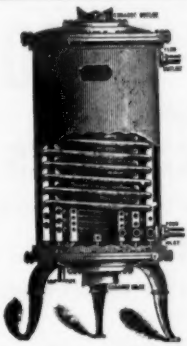

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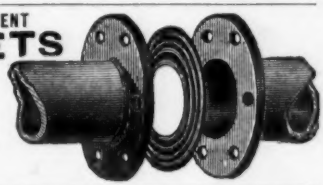

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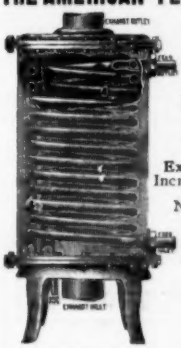

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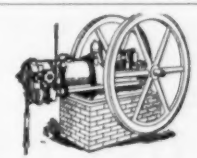

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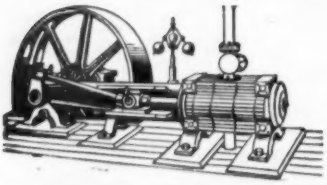

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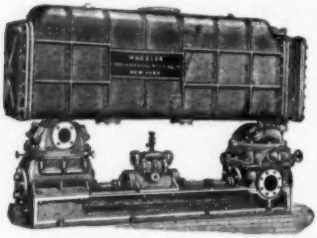

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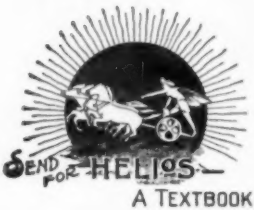

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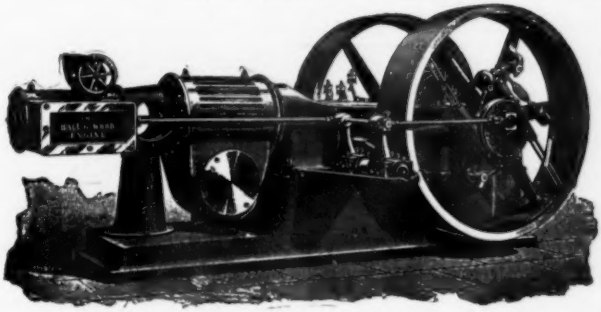

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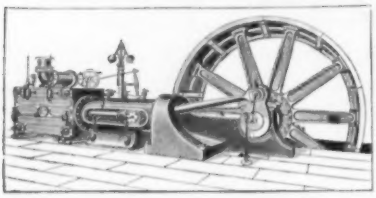

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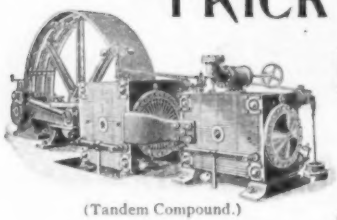

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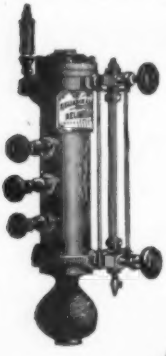

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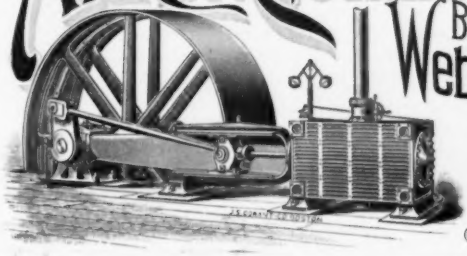

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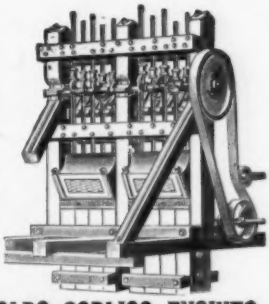

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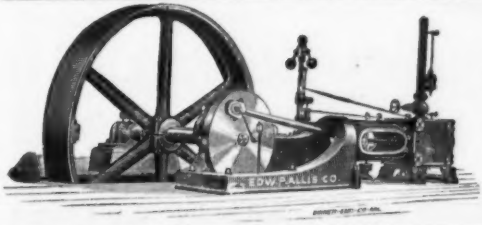

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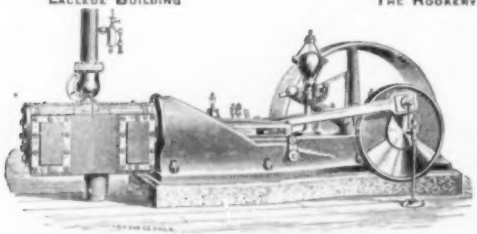

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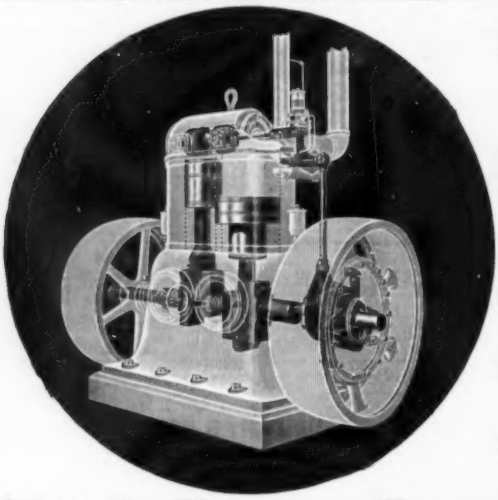

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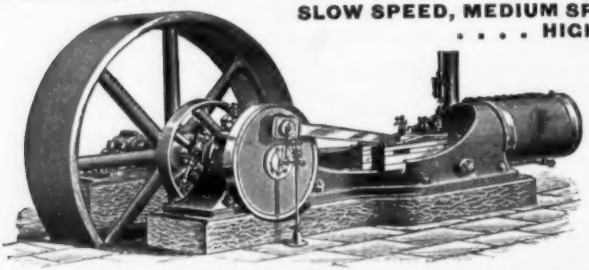

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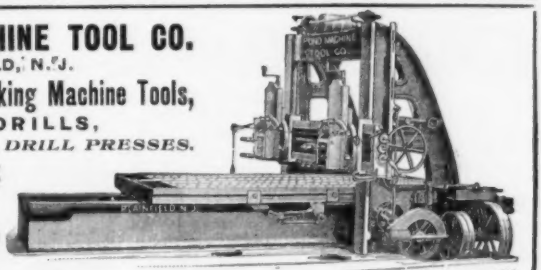

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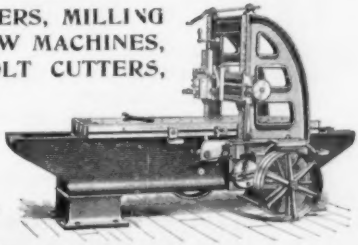

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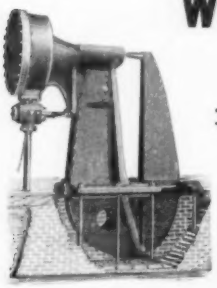

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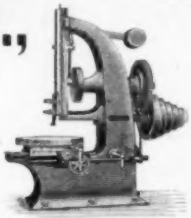

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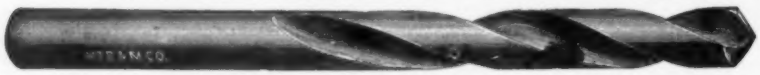

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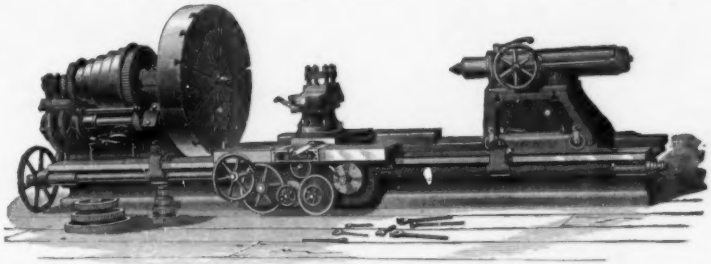

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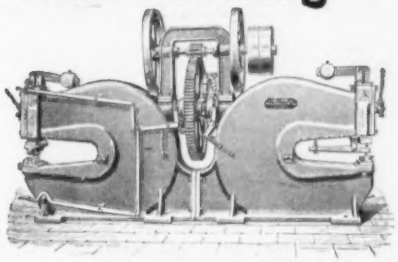

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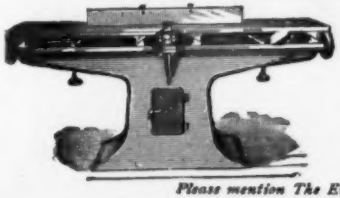

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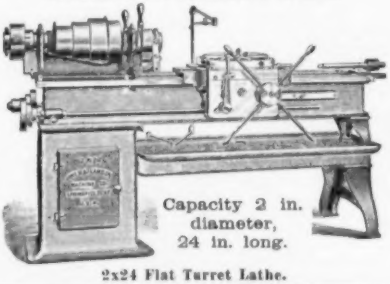

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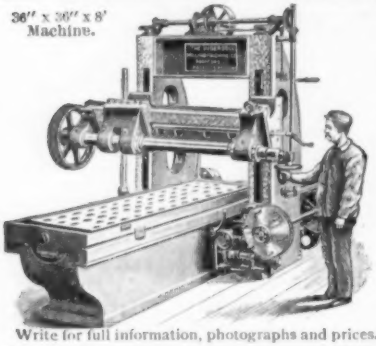

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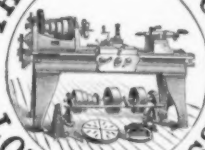

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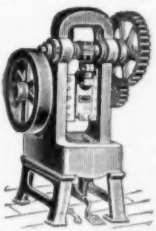

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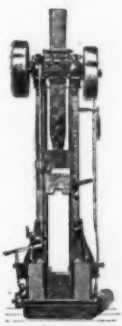

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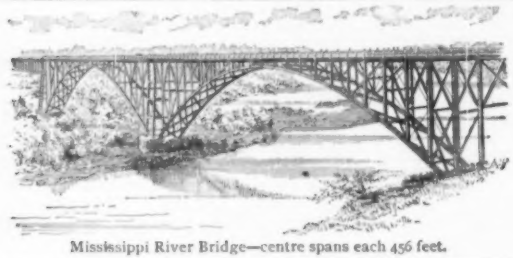

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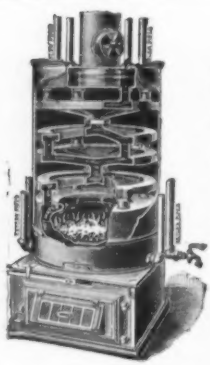

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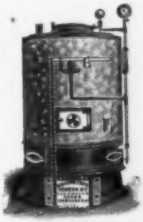

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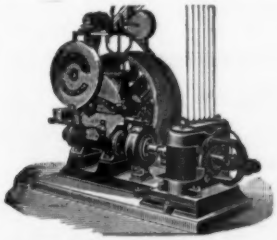

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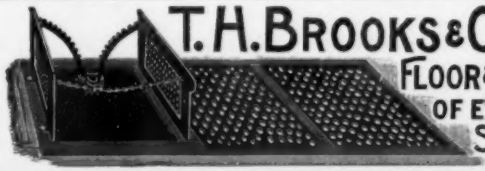

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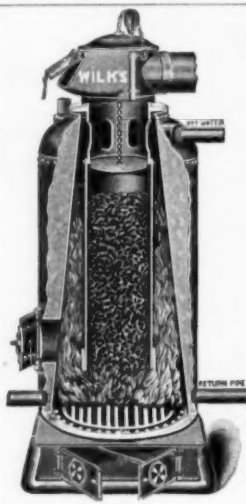

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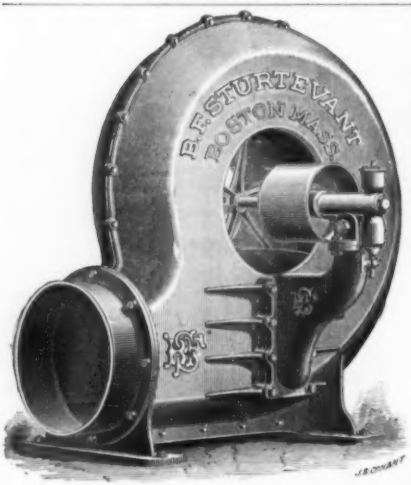

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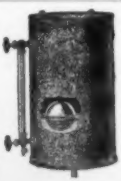

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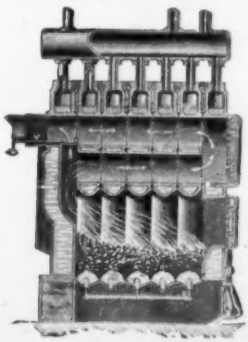

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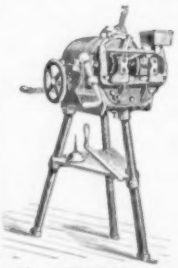

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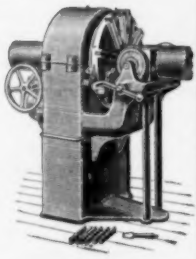

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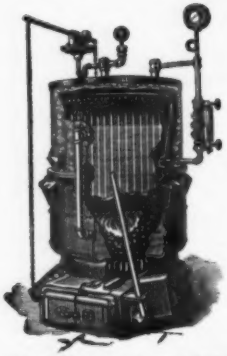

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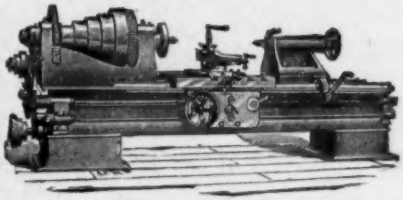

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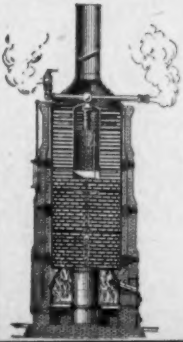

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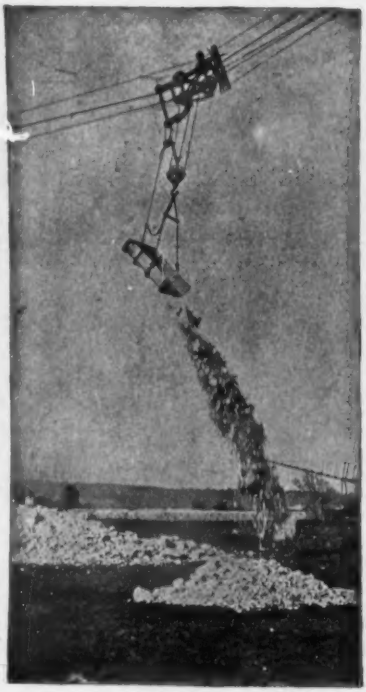

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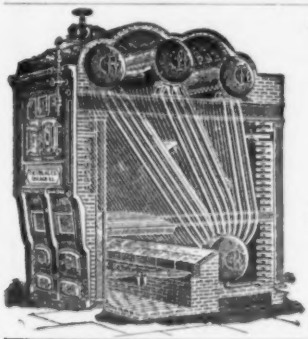

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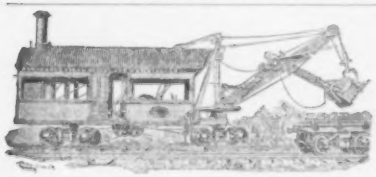

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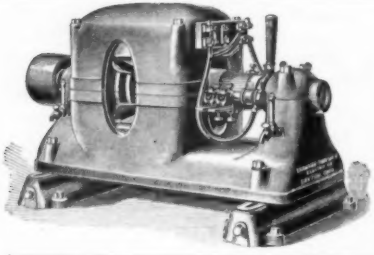

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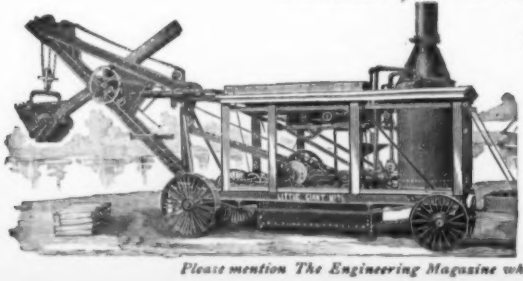

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AUTHORS AND PAPERS THIS MONTH.

HORACE WHITE (*Money and Banking*)=Born in Colebrook, N. H., in 1834; his family soon removed to Wisconsin, and he graduated at Beloit College in 1853. He was for many years connected with the Chicago *Tribune*, and from 1864 to 1874 was its editor-in-chief. In 1881 he became one of the editors of the New York *Evening Post*. He has long paid especial attention to financial subjects.

ALBERT WILLIAMS, JR. (*An Interesting Chapter in Speculative History*)=Born in San Francisco in 1852; graduated from Phillips Academy, Andover, 1868; from Princeton, 1872; of which institution he is a fellow in experimental science; took a special course at the Columbia College School of Mines, 1872–73; has had wide practice as a mining and metallurgical expert in various districts of this country and Mexico; formerly chief of the division of mining statistics and technology of the United States Geological Survey, organizing that service and publishing the annual reports from 1882 to 1885; organized the Michigan Mining School at Houghton, 1886–87; as a writer on scientific, technical and economic subjects has contributed largely to the scientific and technical press during twenty years.

FRANKLIN LEONARD POPE (*The Distribution of Electric Power at Nigara*)=Born 1840, at Great Barrington, Mass.; entered the service of the American Telegraph Company at that place in 1857, and learned both the Hughes printing, and Morse telegraph systems; in 1860 he was employed in the office of the *Scientific American;* in 1865 he was appointed an engineer on the staff of Col. Chas. T. Bulkley, and was engaged in an exploration in British Columbia and Alaska for the Collins Overland Telegraph until 1867; was editor of the *Telegrapher* in 1868; engaged in the business of electric railroad signals soon after, and made many important inventions in that field; was for several years patent attorney and expert for the Western Union Telegraph Company, and relinquished that position to engage in similar work on his own account; in 1884 he also assumed editorial management of the *Electrician and Electrical Engineer*, which afterwards became the weekly *Electrical Engineer;* author of "Modern Practice of the Electric Telegraph," now a standard work. Mr. Pope practiced for many years as electrical expert in some of the most important patent controversies. His recent death in the old homestead at Great Barrington,—the result of an electric shock while adjusting a transformer in the cellar of the mansion, was announced in our November number. He was at work on the article printed in this number at the time of his death.

ROBERT H. THURSTON (*Aim and Scope of the Engineering Colleges*)=Was born in Providence, R. I., October 25, 1839; was graduated from Brown University, 1850, from which he received the degree of LL.D.; was for ten years in the United States Naval engineers; was in active service throughout the war; assisted in organizing the Stevens Institute of Technology, and was for fourteen years professor of engineering there; accepted in 1885 his present position of director of the Sibley College of Mechanical Engineering at Cornell University; first president (1880–82) American Society of Mechanical Engineers; is a member of many other learned societies; has written much on the steam-engine and other subjects.

DR. CHARLES E. EMERY (*The Bearing of Shop Practice*)=Born March 29, 1838, at Aurora, N. Y.; practiced land surveying and learned the use of tools in a shop in youth; during the war in Engineer Corps of the U. S. Navy, participated in engagements on the Mississippi river and in operations off Charleston, and subsequently on experimental duty in New York till

close of war; consulting engineer of the U. S. Coast Survey and U. S. Revenue Marine services for about 21 years, and made experiments with compound and non-compound engines published all over the world; honorary degree of Doctor of Philosophy conferred soon after; built the plant of the Steam Company in New York—cost nearly $2,000,000, resigning in 1887; at present practicing as consulting engineer and as expert in cases relating to the condemnation of water power and important patents suits; juror of group XX, Centennial Exhibition, prime movers and motors of all kinds, and a judge in the Department of Electricity of the Columbian Exposition.

ALEXANDER EWING OUTERBRIDGE, JR. (*Value of Manual Training Schools*) = Born in Philadelphia, 1850; educated at Episcopal Academy and by private tutor in analytical chemistry; lectured on physics and taught English branches at Episcopal Academy 1868-69; appointed assistant in assay laboratory of United States Mint, Philadelphia, 1869; appointed Commissioner to Centennial Exposition, representing Colonies of British Guiana, 1876; invented and tested at United States Mint, Philadelphia, an apparatus for saving volatilized bullion, which was fully endorsed and recommended for adoption in official letters of the late Prof. James C. Booth, then "melter and refiner," and the late Wm. E. DuBois, then "Chief Assayer," 1879; transferred to Mint at New Orleans to organize Assay Department 1879; resigned from Mint 12 years later to accept position as Metallurgist and Experimentalist at car-wheel works of A. Whitney & Sons, Philadelphia 1881; appointed member of board of examiners of International Electrical Exposition Philadelphia 1885; awarded the John Scott Legacy medal and premium by the city of Philadelphia on recommendation of the Franklin Institute for discovery of process of casting molten metals on carbonized fabrics and obtaining replicas thereof, 1887; resigned from car-wheel works and accepted a similar position at machine tool works of Wm. Sellers and Co. incorporated 1888. Has been a voluminous contributor to scientific and technical publications of first rank and has delivered addresses before numerous learned bodies.

FLOYD DAVIS, E. M., Ph. D. (*Investigation of Public Water Supplies*) = Born May 29, 1859, at Ithaca, N. Y.; educated at Missouri University, Ohio State University, Cornell University and Johns Hopkins University; formerly a Professor in the Virginia Agricultural and Mechanical College, Drake University of Wisconsin, and President of the New Mexico School of Mines, besides being State chemist of Iowa for several years. Professor Davis' home is at Des Moines, Iowa, where he is an analytical and consulting chemist. He has had wide experience in his profession, and has made a special study of the selection and purification of water supplies, having analyzed more than two thousand western waters. He is the author of Davis' Handbook on Potable Water, and is a frequent contributor to the leading magazines. In 1891-92, he prepared several articles on water for this Magazine.

SAMUEL WARD STANTON (*The Great Modern Transatlantic Steamers*) = Born January 8, 1870, in Newburg, N. Y.; youngest son of the late Samuel Stanton, of the ship building firm of Ward, Stanton & Co.; became part owner of shipping journal *Seaboard*, New York, in 1891; was awarded medal and diploma at the World's Columbian Exposition, Chicago, 1893, for a historical collection of pen drawings of steamers of the United States, past and present; has published a successful 500 page book, entitled, "American Steam Vessels."

J. F. WALLACE, M. Am. Soc. C. E. (*The Cost of Modern Railroad Construction*) = Mr. Wallace has been engaged in various important railroad construction and engineering works in the central portion of the United States continuously during the last twenty-six years, and is now Chief Engineer of the Illinois Central and Yazoo & Mississippi Valley R. R.'s. In these roads are comprised seventeen different railroad companies, making up the Illinois Central R. R. system, with lines extending from Dakota to Louisiana and crossing or entering ten different States. Mr. Wallace's varied experience in railroad construction, operation and maintenance enables him to not only treat this subject in concise and popular style, but also to set forth graphically the different items that make up railroad construction, and while presenting the matter in simple and comprehensive form, to give information that should be of great value to investors in railroad properties, whether actually constructed or contemplated.

E. C. GARDNER (*Schools and School-House Architecture*) = Born in Ashfield, Mass., in 1836; 1856 to 1862 engaged in teaching; studied architecture in Springfield, Mass., in 1862; soon after went into business alone; first book on domestic architecture was published in 1872; followed by two other similar volumes; author of "Common-sense in Church Building," "The House that Jill Built," and "Village and Suburban School Houses"; member of Boston Society of Architects; 1885 till 1888 editor of *Builder*; at present senior member of the architectural firm of Gardner, Pyne & Gardner, Springfield, Mass.

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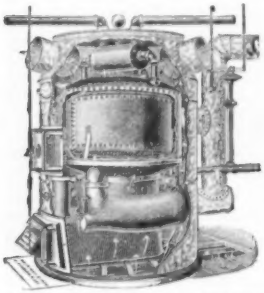

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Riter & Conley, Pittsburg, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Stirling Co., Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.

Boiler Compound.

Geo. W. Lord, Philadelphia, Pa.

Boiler Fronts and Fittings.

Reliance Gauge Co., Cleveland, Ohio.
Riter & Conley, Pittsburg, Pa.
Vulcan Iron Works, Toledo, Ohio.

Boiler Inspectors.

Hartford S. B. I. & Ins. Co., Hartford, Conn.

Boring Machines.

Fitchburg Machine Works, Fitchburg, Mass.

Bolts, Nuts, and Washers.

Milton Mfg. Co., Milton, Pa.

Bricks.

Empire Fire-Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
Pittsburg Terra Cotta Lumber Co, Pittsburg, Pa.

Bridge Builders.

F. C. Austin Mfg. Co., Chicago, Ill.
Berlin Iron Bridge Co., East Berlin, Conn.
The Continental Iron Works, Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Brick and Tile Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co. Columbus, Ohio.

Building Materials.

Berlin Iron Bridge Co., East Berlin, Conn.
T. H. Brooks & Co., Cleveland, Ohio.
Canton Steel Roofing Co., Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Empire Fire-Proofing Co., Pittsburgh, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Harrison Bros & Co., Philadelphia, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
James L. Foote, Slatington, Pa.
Joseph Dixon Crucible Co., Jersey City, N. J.
Maryland Steel Co., Sparrows Point, Md.
Milton Mfg. Co., Milton, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Pittsburg Terra Cotta Lumber Co, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Standard Paint Co, 2 Liberty St., N. Y.
Warren Chemical and Mfg. Co, 27 Fulton St., N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co., Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Cable Railways.

Robert Poole & Son Co., Baltimore, Md.

Cable Railway Driving Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Cables, Electric and Submarine.

Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Cableways.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calcining and Drying Machines.
F. D. Cummer & Son Co., Cleveland, Ohio.

Calipers and Dividers.
L. S. Starrett, Athol, Mass.

Cameras.
Rochester Optical Co., Rochester, N. Y.

Cams and Tappets.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Carpenters' Tools.
L. S. Starrett, Athol, Mass.

Carriage and Wagon Machinery.
Buffalo Forge Co., Buffalo, N. Y.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Riter & Conley, Pittsburg, Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.
R. D. Wood & Co., Philadelphia, Pa.

Chain Belting.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.

Chemical Works Machinery.
Fraser & Chalmers, Chicago, Ill.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).
Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Clay Working Machinery.
W. J. Clark & Co., Salem, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Closets.
Standard Manufacturing Co., Pittsburg, Pa.

Clutches, Friction.
J. S. Mundy, Newark, N. J.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Coal Mining Machinery.
Buffalo Forge Co., Buffalo, N. Y.
W. J. Clark & Co., Salem, Ohio.
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
General Electric Co., 44 Broad St., N. Y.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
C. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Concentrators and Pulverizers.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Sturtevant Mill Co., Boston Mass.

Condensers, Jet.
Deane Steam Pump Co., Holyoke, Mass.

Condensers, Surface.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.

Consulting Engineers.
Alton D. Adams, Worcester, Mass.
D. Ashworth, Pittsburg, Pa.
Wm. H. Bryan, St. Louis, Mo.
C. M. Conradson, Madison, Wis.
E. L. Corthell 71 Broadway, New York.
Henry C. Eddy, Chicago, Ill.
Dr. Willis E. Everette, Tacoma, Wash.
M. Fargusson, Southport, N. C.
C. T. Gooding, Tucson, Ariz.
E. B. Hussey, Seattle, Wash.
E. P. Jennings, Ironwood, Mich.
Julian Kennedy, Pittsburg, Pa.
A. L. McRae, Austin, Texas.
Frank Nicholson, Phoenix, Ariz.
Pittsburg Testing Lab'y, Ltd., Pittsburg, Pa.
Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
Vandenbergh Lab'y of Chem. Ind., Buffalo, N. Y.
Wm. O. Webber, Boston, Mass.

Contractors' Dump Cars, etc.
Gates Iron Works, Chicago, Ill.
Sheffield Car Co., Three Rivers, Mich.

Contractors' Supplies.
F. C. Austin Mfg. Co., Chicago Ill.
Thomas Carlin's Sons, Allegheny, Pa.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
W. J. Clark & Co., Salem, Ohio.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link Belt Engineering Co., Phila., Pa.

Copper.
Canadian Copper Co., Cleveland, O.

Corliss Engines.
Edw. P. Allis Co., Milwaukee, Wis.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio
Maryland Steel Co., Sparrows Point, Md.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Corrugated Iron.
Berlin Iron Bridge Co., East Berlin, Conn
Wheeling Corrugating Co., Wheeling, W. Va.

Cranes.
Berlin Iron Bridge Co., East Berlin, Conn.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
Earle C. Bacon 26 Cortlandt St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Crushers, Ore, Phosphate, Rock.
Edw. P. Allis Co., Milwaukee, Wis.
F. C. Austin Mfg. Co., Chicago, Ill.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Sturtevant Mill Co., Boston, Mass.

Diamond Drills.
M. C. Bullock Mfg. Co., Chicago, Ill.

Fraser & Chalmers, Chicago Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.

Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Dredging Machines.

W. J. Clark & Co., Salem, Ohio.
W. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

Buffalo Forge Co., Buffalo, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Presses.

Merrill Bros., Brooklyn, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.

Dynamos.

Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Shawhan-Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electric Railway Supplies.

Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Morris, Tasker & Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh Pa.

Electrical Instruments.

Bristol Co., Waterbury, Conn.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Queen & Co., Inc., Philadelphia, Pa.
Shawhan-Thresher Electric Co., Dayton, O.
Standard Electric Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, Ohio.
United Electric Telephone Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
H. K. Porter & Co., Pittsburg, Pa.

Electrical Rubber Goods.

Home Rubber Co., Trenton, N. J.
Spinney, Virtue & Co., Lynn, Mass.

Electroplating and Electrotyping Machines.

Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Elevators, Steam, Hydraulic, Electric.

M. J. O'Donnell & Co., Cleveland, Ohio.

Emery Wheels.

Manhattan Rubber Mfg. Co., 61 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.

Bignall & Keeler Mfg. Co., St. Louis, Mo.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.

Engine Lathes.

Lodge & Davis Machine Tool Co., Cincinnati, Ohio.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petrol um.

Otto Gas Engine Works, Philadelphia, Pa.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Poin

Engines, Stationary.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Colorado Iron Works, Denver, Colo.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Southwark Foundry and Machine Co., Phila., Pa
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robert Wetherill & Co., Chester, Penn.

Evaporators.

Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y

Excavators.

Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Expansion Tanks.

Hepe, Koven & Co., 18 Spruce St., N. Y.

Extensible Sewer Brace.

Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng Co., 39 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Files.

Nicholson File Co., Providence, R. I.

Filters.

Continental Filter Co., 44 Wall St., N. Y.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Fire Department Equipment.

American Ball Nozzle Co., 837 Broadway, N. Y.

Fireproof Building Material.

Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co , Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Empire Fire Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
James L. Foote, Slatington, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Milton Mfg. Co , Milton, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co. Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co,, Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill,
Robert Poole & Son Co., Baltimore, M
Walker Manufacturing Co., Cleveland, Ohio.

Foot and Hand Presses.

Toledo Machine & Tool Co., Toledo, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.

Forgings.

Milton Mfg. Co., Milton, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.

Furnace Builders.

Fraser & Chalmers, Chicago, Ill,
Julian Kennedy, Pittsburgh, Pa.
Riter & Conley, Pittsburg, Pa.

Furniture.

The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.

C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure, Steam, Water, etc.

Bristol Co., Waterbury, Conn.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Coldwell-Wilcox Co., Newburgh, N. Y.
Continental Iron Works, Brooklyn, N. Y.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.

Gear Cutters.

Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
General Electric Co., 44 Broad St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grading Machines.

F. C. Austin Mfg. Co., Chicago, Ill.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y,

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hand Cars.

Sheffield Car Co., Three Rivers, Mich.

Hangers.

SEE PULLEYS, ETC.

Hardware Manufacturers.

Charles H. Besly & Co., Chicago, Ill.
Merrill Bros , Brooklyn, N. Y.
L. S. Starrett, Athol, Mass.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

American Boiler Co., Chicago, Ill.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
S. Wilks Mfg. Co , Chicago, Ill.
Smith & Anthony Company, Boston, Mass.
United States Heater Co., Detroit, Mich.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Brown Hoisting & Conveying Mch . Co., Clevel'nd, O.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y
Cooper, Hewitt & Co., 17 Burling Slip, N. Y
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio
Webster, Camp & Lane Machine Co., Akron, Ohio.

Hod Hoisting Machinery.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Hollow Bricks.

Empire Fire-Proofing Co., Pittsburgh, Pa.
Henry Maurer & Son, 420 E. 23d St , New York,
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.

Hydraulic Machinery.

Fraser & Chalmers, Chicago, Ill.
New York Belting & Packing Co., Ltd., New York,
Maryland Steel Co , Sparrows Point, Md
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Queen & Co., Inc., Philadelphia, Pa.

Injectors.

American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.
W. R. Brixey, 203 Broadway, N. Y.
Eastern Electric Cable Co., Boston, Mass.
General Electric Co., 44 Broad St., N. Y.
The Okonite Co., Limited, 13 Park Row, N. Y.

Insulating Paper.
Standard Paint Co., 2 Liberty St., N. Y.

Iron Working Machinery.
Charles H. Besly & Co., Chicago, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Gould & Eberhardt, Newark, N. J.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Long & Allstatter Co., Hamilton, Ohio
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Merrill Bros., Brooklyn, N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Joists, Iron and Steel.
Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Kyanizing.
Otis Allen & Son, Lowell, Mass.

Lamps, Electric.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.
Bradford Mill Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Lead Corroders.
Harrison Bros. & Co., Philadelphia, Pa.

Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
Pittsburg Locomotive Works Pittsburg, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Thomas Carlin's Sons, Allegheny, Pa.

Locomotive Brakes.
Westinghouse Air Brake Co., Pittsburgh, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Lubricants.
Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.
Sherwood Mfg. Co., Buffalo, N. Y.

Lumber and Shingles.
Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Machine Screws, etc.
Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.
Armstrong Bros. Tool Co., Chicago, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Charles H. Besly & Co., Chicago Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Gould & Eberhardt, Newark N. J.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio,
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Merrill Bros., Brooklyn, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Marine Machinery.
W. A. Crook & Bros Co., Newark, N. J.
Marine Iron Works, Chicago, Ill.

Mathematical Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Merchant Steel.
Wm. Jessop & Sons, Limited. 91 John St., N. Y.

Metal Punching and Shearing.
Harrington & King Perforating Co., Chicago, Ill.

Metallurgical Supplies.
Colorado Iron Works, Denver, Colo.

Meters, Electric.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.

Meters, Water.
Deane Steam Pump Co., Holyoke, Mass.

Milling Machines.
Ingersoll Milling Machine Co., Rockford, Ill.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.

Mine Cars
Colorado Iron Works, Denver, Colo.

Mining Machinery
Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
Colorado Iron Works, Denver, Colo.
W. A. Crook & Bros. Co., Newark, N. J.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y
Jeffery Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Mining Screens.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., N. Y.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Shawhan-Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa

Nickel.
Canadian Copper Co., Cleveland, O.

Nut Locks.
Eureka Nut Lock Co., Pittsburg, Pa.

Oil Cups
Sherwood Mfg. Co., Buffalo, N. Y.

Ore Roasting Machinery.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.

Ornamental Iron Work.
Winslow Bros. Co., Chicago, Ill.

Packing
The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Sherwood Mfg. Co., Buffalo, N. Y.

Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Joseph Dixon Crucible Co., Jersey City, N. J.
Harrison Bros. & Co., Philadelphia, Pa.
Standard Paint Co., 2 Liberty St., N. Y.

Paints (Special for Iron.)
SAME AS ABOVE.

Paper Mill Machinery.
Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Penstocks.
Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds).
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.
Rochester Optical Co., Rochester, N. Y.

Pipe, Cast Iron.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
Jeanesville Iron Works, Jeanesville, Pa.
Charles Millar & Son, Utica, New York.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.
National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.
A. Wyckoff & Son, Elmira, N. Y.
Manville Covering Co., Milwaukee, Wis.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Pipe Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn
Bignall & Keeler Mfg. Co., St. Louis, Mo.

Pipe, Sewer.
Charles Millar & Son, Utica, New York.
Union Sewer Pipe Co., Akron, Ohio.

Pipe, Wrought Iron, Line and Drive.
Crane Company, Chicago, Ill.
Morris, Tasker & Co., Philadelphia Pa.

Planing Mill Machinery.
C. B. Rogers & Co., Norwich, Conn.

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Eddy Electric Manufacturing Co., Windsor, Conn.
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Portable Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Power Punches and Shears.
Long & Allstatter Co., Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Power Transmission, Electric.
General Electric Co., 44 Broad St., N. Y.

Preservation of Lumber.
Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic.
Maryland Steel Co., Sparrows Point, Md.
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Walker Manufacturing Co., Cleveland, Ohio.

Pressure Regulators.
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Fitchburg Machine Works, Fitchburg, Mass.

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Edw. P. Allis Co., Milwaukee, Wis.
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Fishkill Landing Machine Co., Fishkill, N. Y.
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Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

Pulverizers.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Fraser & Chalmers, Chicago, Ill.

Pumps and Pumping Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y
Colorado Iron Works, Denver, Colo.
Connersville Blower Co., Connersville, Ind.
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Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
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Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J

Radiator Screens.
Harrington & King Perforating Co., Chicago, Ill.

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Crane Company, Chicago, Ill.
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Niles Tool Works, Hamilton, Ohio.
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C. B. Rogers & Co., Norwich, Conn.
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Stow Manufacturing Co., Binghamton, N. Y.
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Hepe, Koven & Co., 18 Spruce St., N. Y.

Red Lead.
Harrison Bros. & Co., Philadelphia, Pa.

Reducing Valves.
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Gates Iron Works, Chicago, Ill.

Rock Drills.
M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Works, 26 Cortlandt St., N. Y
Fraser & Chalmers, Chicago, Ill.
General Electric Co., 44 Broad St., N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 23 Park Place, N. Y.
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Long & Allstatter Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
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Continental Iron Works, Brooklyn, N. Y.
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Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.
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Schools.
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Correspondence School of Technology, Cleveland, O.
Lawrence Scientific School, Cambridge, Mass.

Scrapers, Wheel and Drag.
F. C. Austin Mfg. Co., Chicago, Ill.

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Fraser & Chalmers, Chicago, Ill.
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Screen Plates, Punched.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.

Screw Machines.
Bignall & Keeler Mfg. Co., St. Louis, Mo.
Jones & Lamson Mch. Co., Springfield, Vt
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Niles Tool Works, Hamilton, Ohio.

Sectional Coverings.
Manville Covering Co., Milwaukee, Wis.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Separators, Coal and Ore.
F. D. Cummer & Son Co., Cleveland, Ohio.
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Sewer Pipe.
Charles Millar & Son, Utica, New York.
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Shafting.
SEE PULLEYS, ETC.

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Hepe, Koven & Co., 18 Spruce St., N. Y.

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Toledo Machine & Tool Co., Toledo, Ohio.

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Chrome Steel Works, Brooklyn, N. Y.
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Canton Steel Roofing Co., Canton, Ohio.

Slate.
James L. Foote, Slatington, Pa.

Smokestacks.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

Spark Guards, Perforated.
Harrington & King Perforating Co., Chicago, Ill.

Standpipes.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

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Crane Company, Chicago, Ill.

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Chapman Valve Mfg. Co., Indian Orchard, Mass.
Coldwell-Wilcox Co., Newburgh, N. Y.
The Fairbanks Co., New York.
Penberthy Injector Co., Detroit, Mich.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.
Reliance Gauge Co., Cleveland, Ohio.
Ross Valve Co., Troy, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

Steamships and Tow Boats.
Atlantic Works, East Boston, Mass.

Steam Shovels.
Thomas Carlin's Sons, Allegheny, Pa.
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Buffalo Forge Co., Buffalo, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
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Steam Yachts.
Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.

Steel Importers.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Steel Manufacturers.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Steel, Tool.

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Chrome Steel Works, Brooklyn, N. Y.

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Street Sweepers.

F. C. Austin Mfg. Co., Chicago, Ill.

Structural Iron Work.

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Surveying Instruments.

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Clonbrock Steam Boiler Co., Brooklyn, N. Y.
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Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
S. Wilks Mfg. Co., Chicago, Ill.

Tanks, Wood.

Williams Mfg. Co., Kalamazoo, Mich.

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Telephones.

United Electric Telephone Co., New York.

Testing Machinery.

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Walker Manufacturing Co., Cleveland, Ohio.

Tramways, Wire Rope.

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Fraser & Chalmers, Chicago, Ill,
Trenton Iron Co., Trenton, N. J.
C. W. Hunt Co., 45 Broadway, N. Y.

Transmission Machinery.

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General Electric Co., 44 Broad St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill Co., Chester, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.

Tube Scrapers.

Sherwood Mfg. Co., Buffalo, N. Y.

Turbines.

Dayton Globe Iron Works, Dayton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
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Cleveland Twist Drill Co., Cleveland, Ohio.
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Deane Steam Pump Co., Holyoke, Mass.

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The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Jeanesville Iron Works, Jeanesville, Pa.
Ross Valve Co., Troy, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
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Cook Well Co., St. Louis, Mo.
The Fairbanks Co., New York.
McNeal Pipe and Foundry Co., Burlington, N. J.

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Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
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American Well Works, Aurora, Ill.
Cook Well Co., St. Louis, Mo.

White Lead.

Harrison Bros. & Co., Philadelphia, Pa.

Window Guards (Jail Work.)

Harrington & King Perforating Co., Chicago, Ill.

Wire.

Charles H. Besly & Co., Chicago, Ill.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Cloth.

Fraser & Chalmers, Chicago, Ill.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

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John A. Roebling's Sons Co., Trenton, N. J.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
Trenton Iron Co., Trenton, N. J.

Wire Rope Transmission.

Jeffrey Mfg. Co., Columbus, Ohio.

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Harrison Bros. & Co., Philadelphia, Pa.

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The Wilkinson Co., Chicago, Ill.

Wool Cement.

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Wrecking Cars.

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Yachts, Steam.

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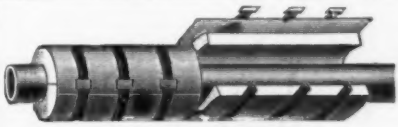

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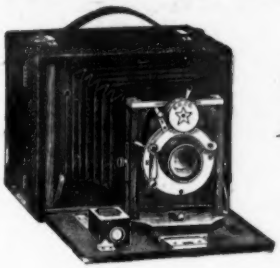

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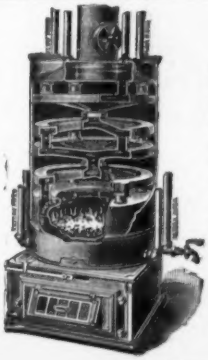

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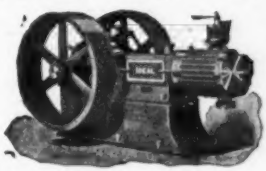

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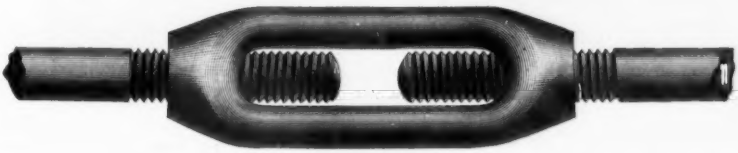

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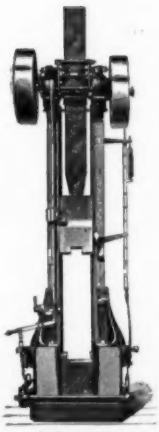

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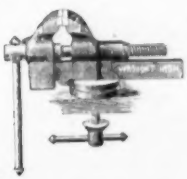

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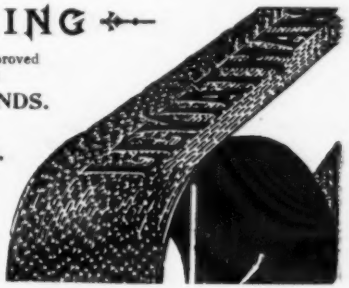

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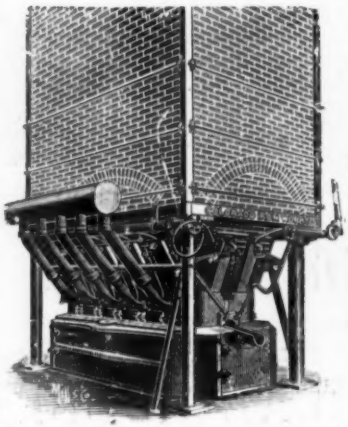

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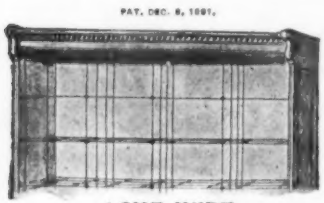

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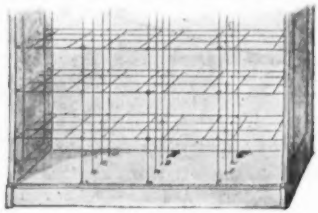

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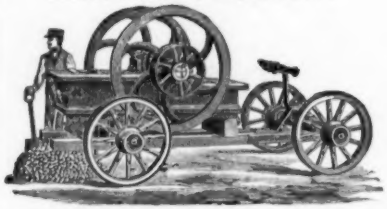

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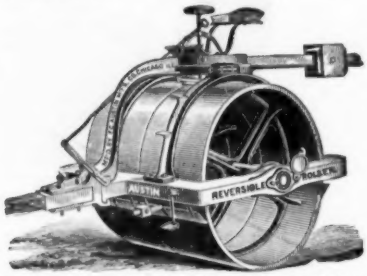

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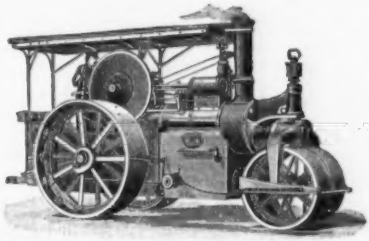

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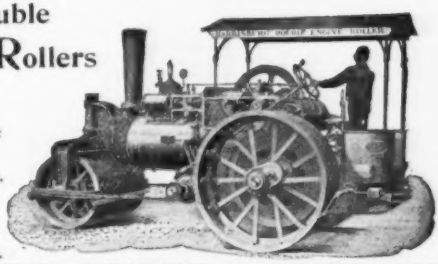

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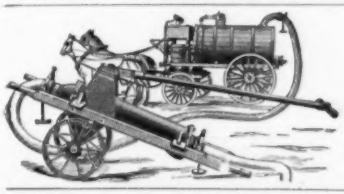

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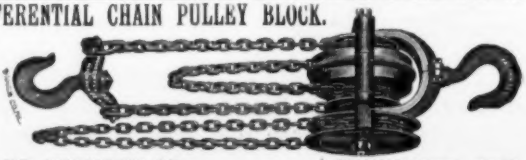

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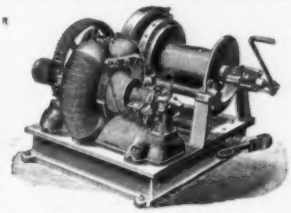

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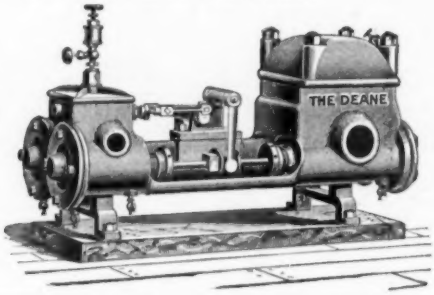

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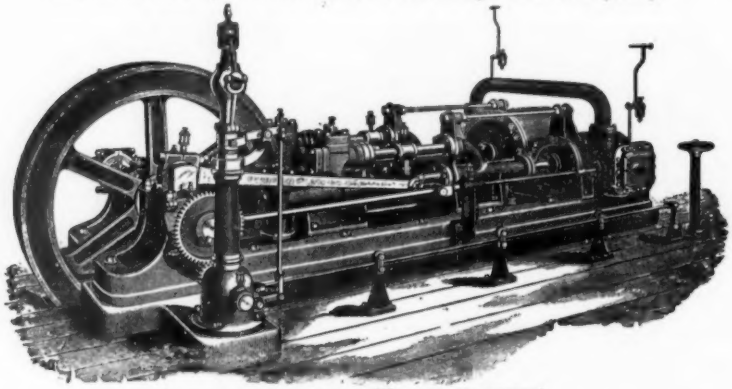

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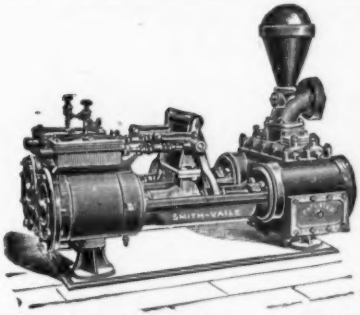

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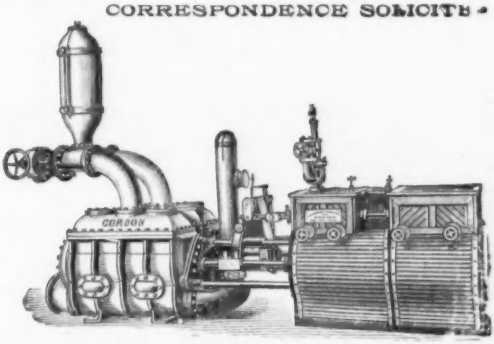

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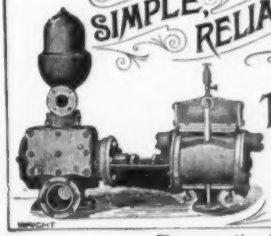

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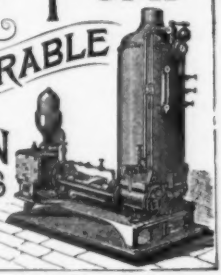

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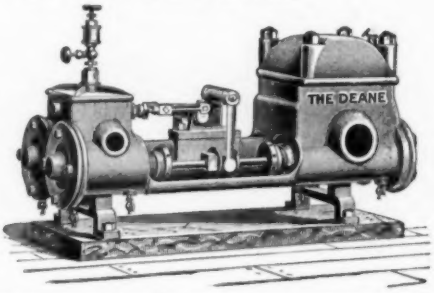

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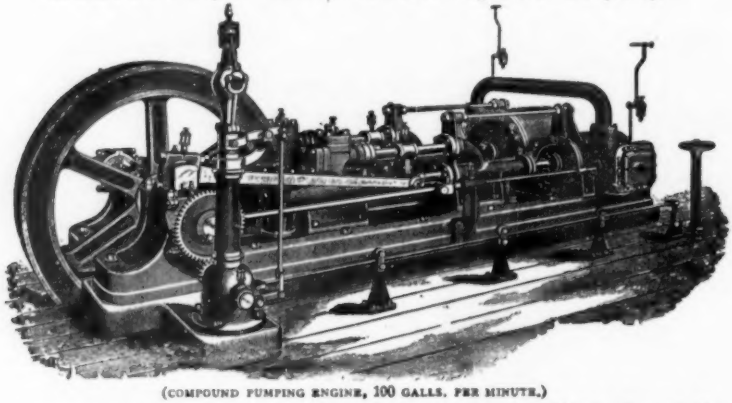

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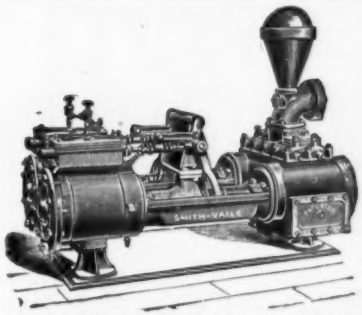

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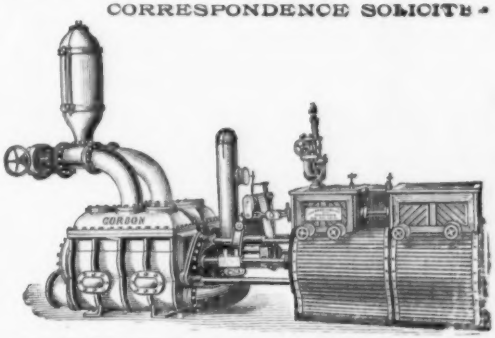

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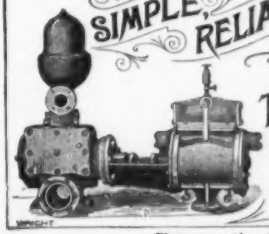

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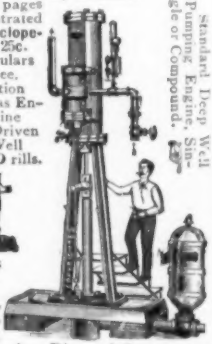

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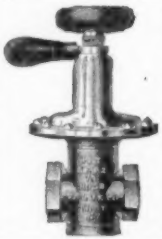

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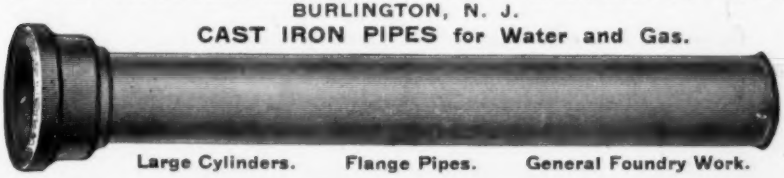

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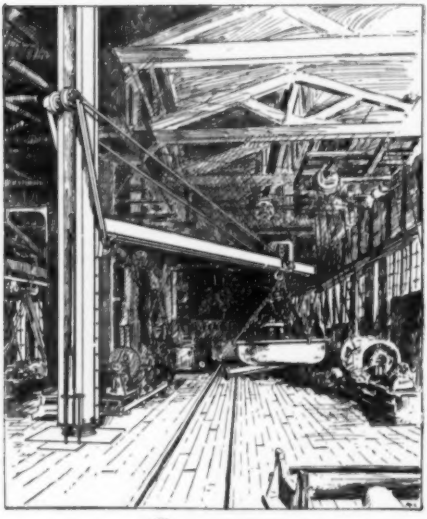

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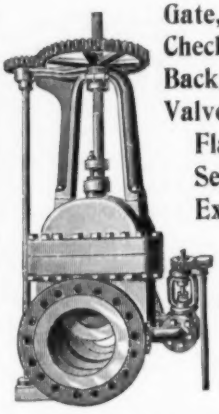

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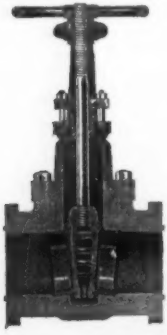

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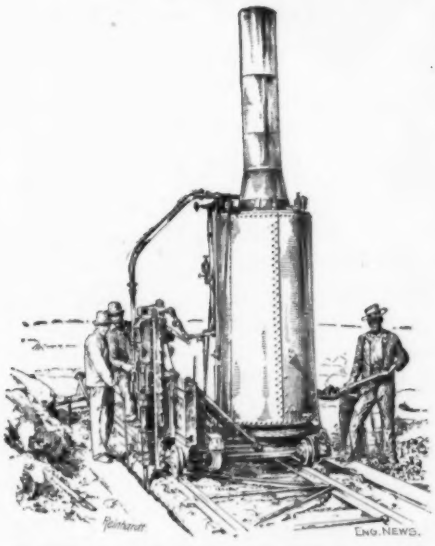

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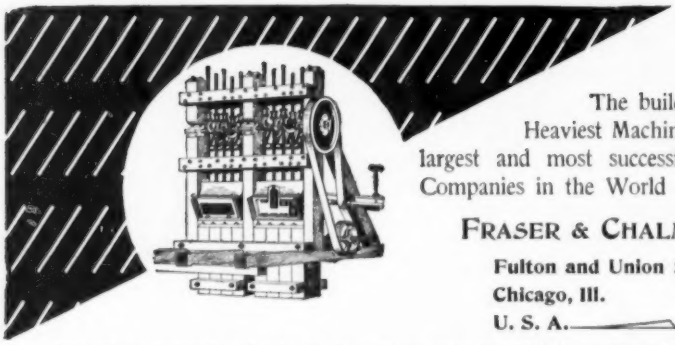

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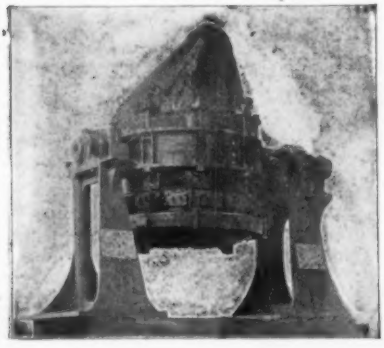

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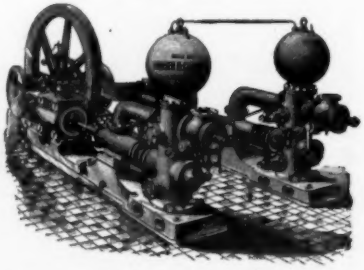

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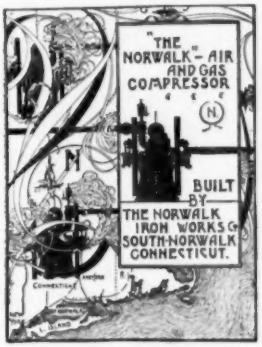

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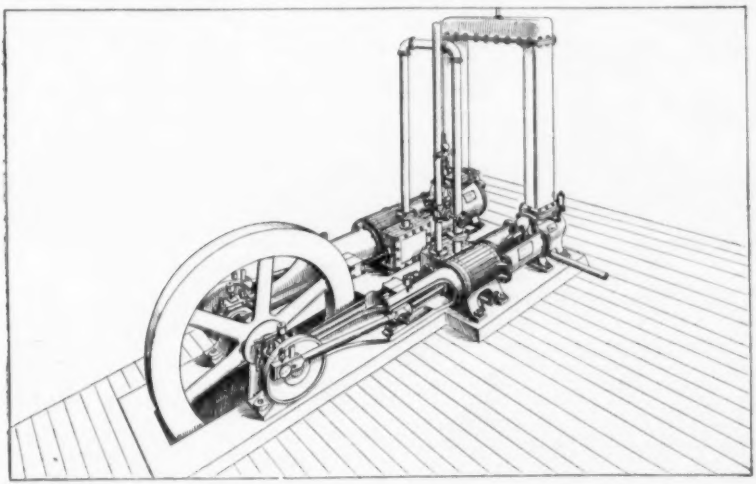

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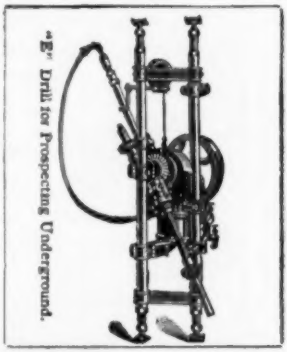

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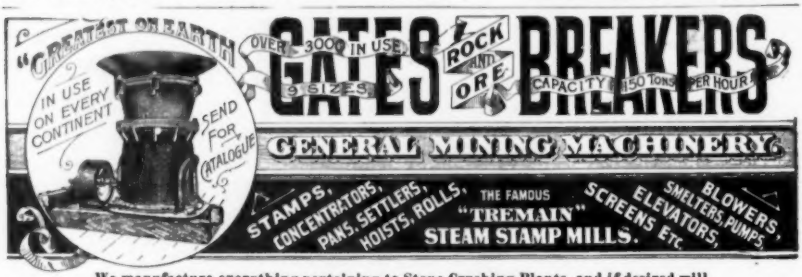

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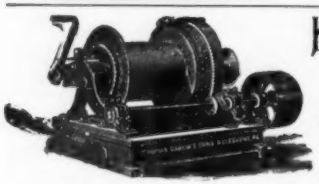

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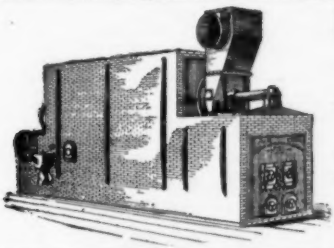

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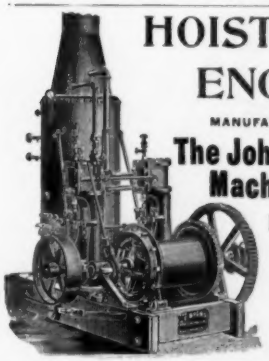

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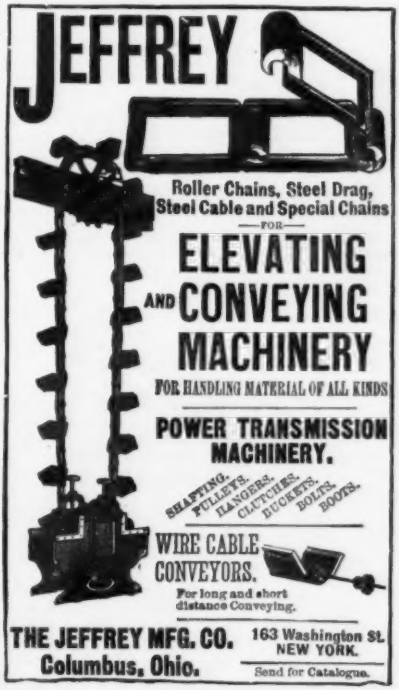

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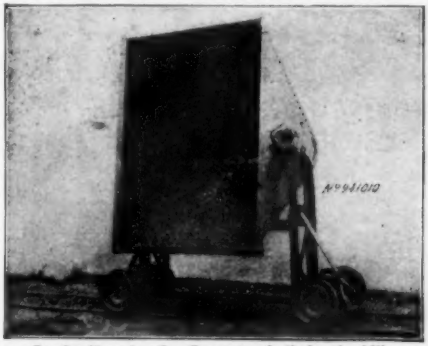

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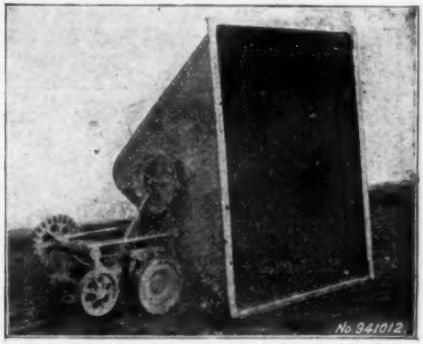

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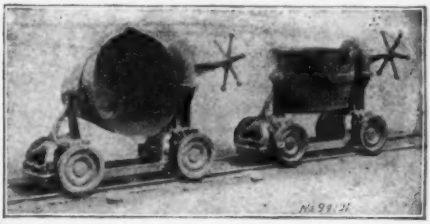

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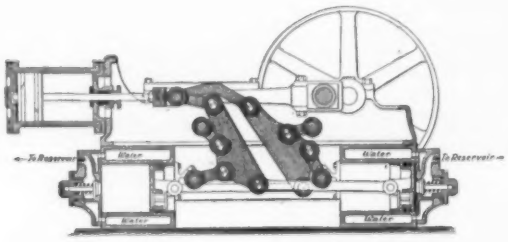

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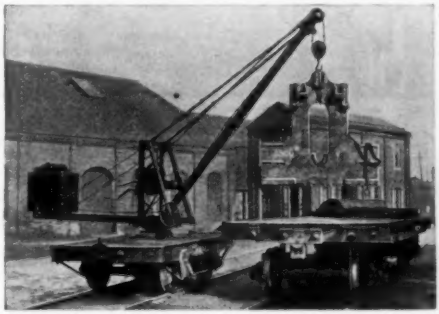

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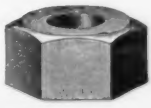

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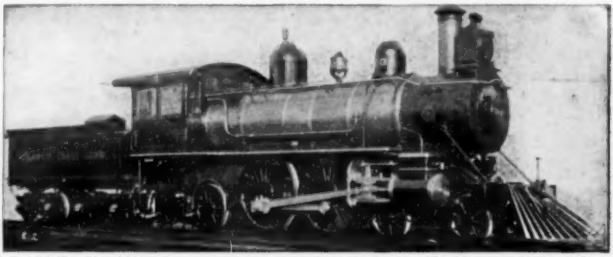

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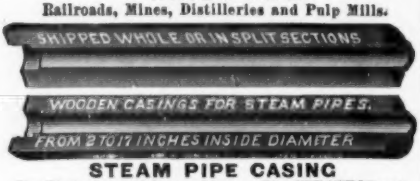

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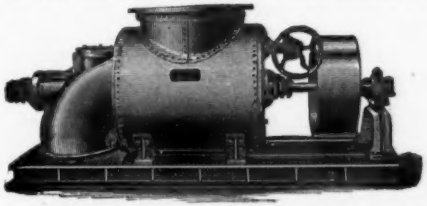

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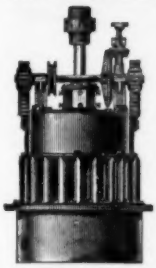

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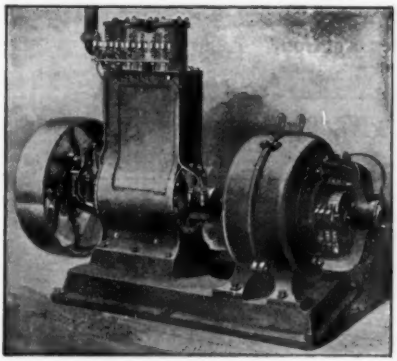

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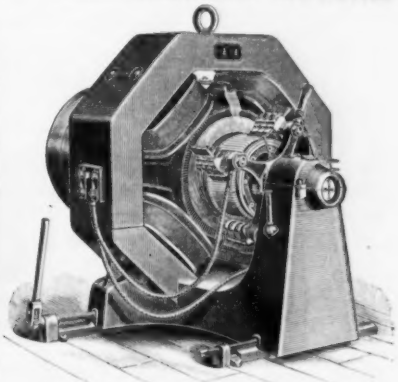

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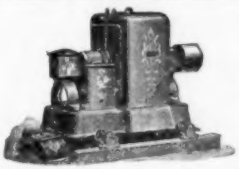

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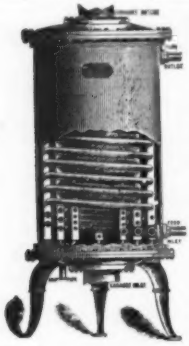

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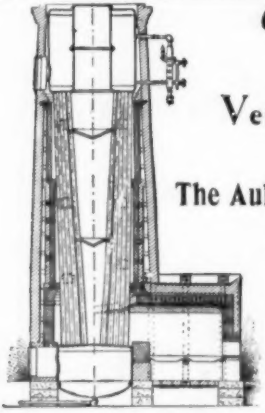

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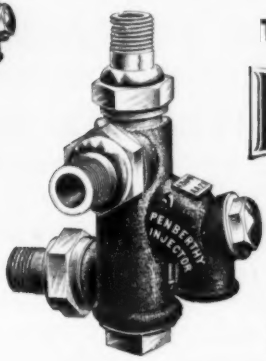

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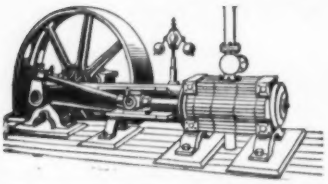

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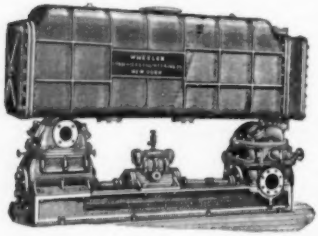

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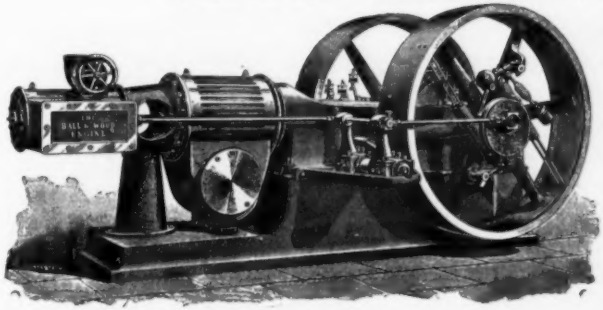

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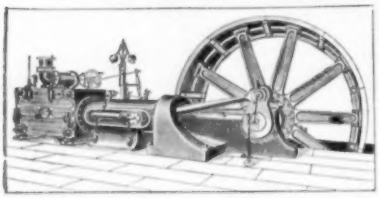

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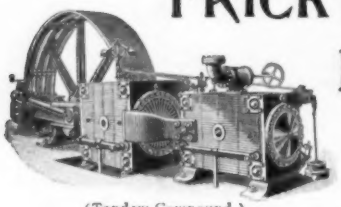

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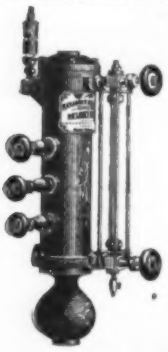

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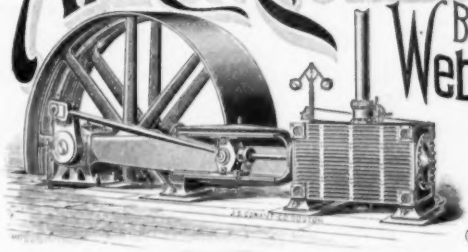

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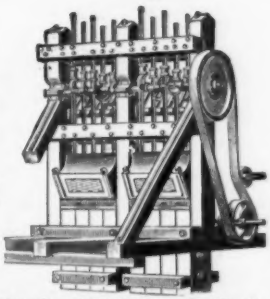

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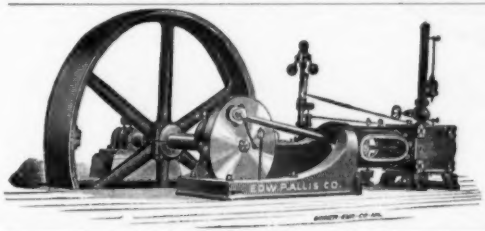

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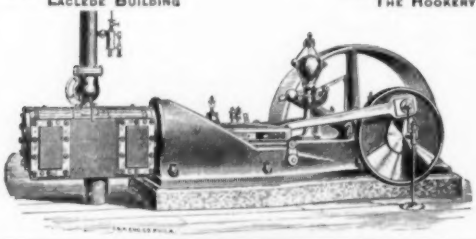

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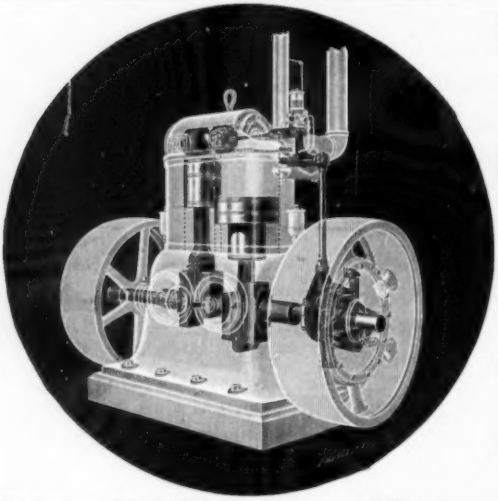

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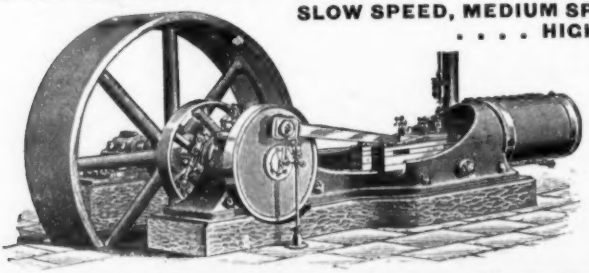

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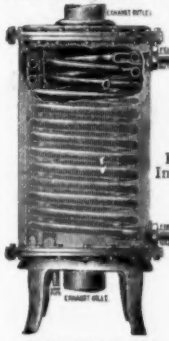

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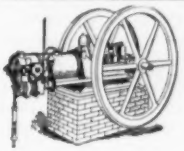

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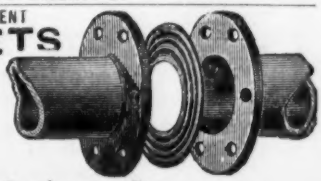

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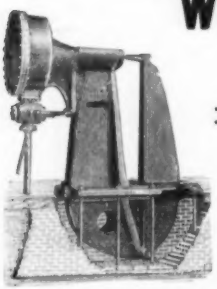

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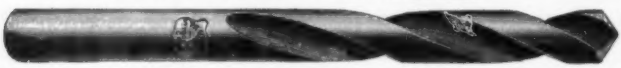

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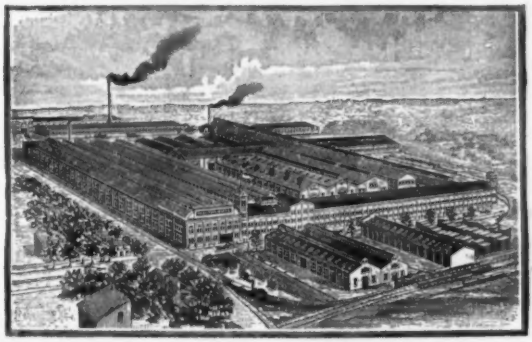

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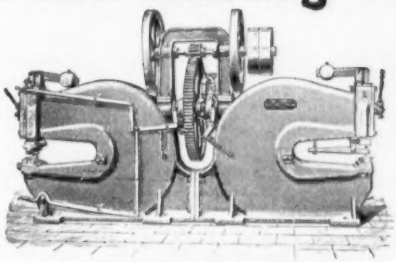

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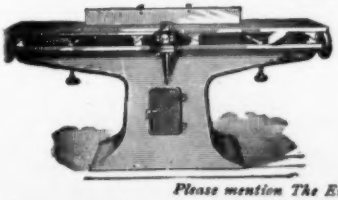

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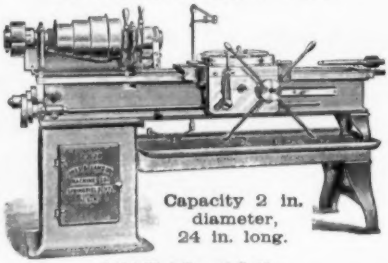

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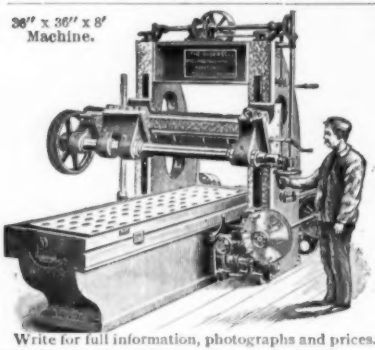

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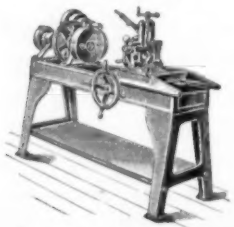

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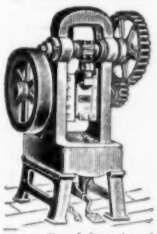

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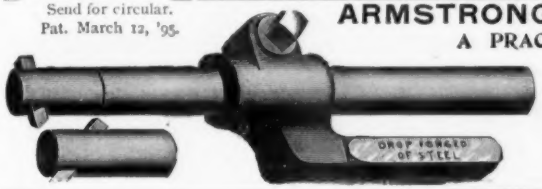

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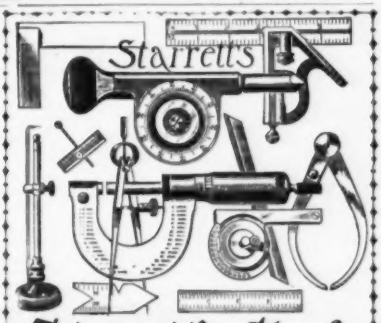

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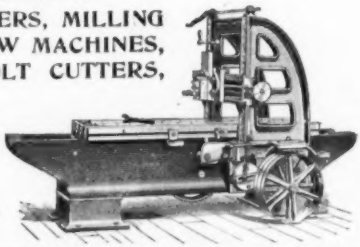

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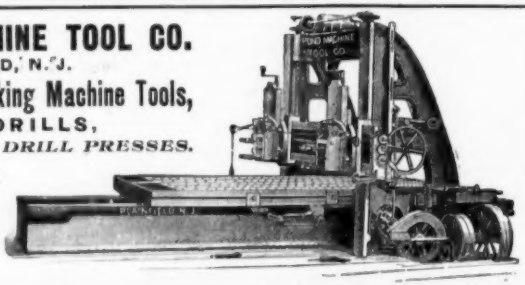

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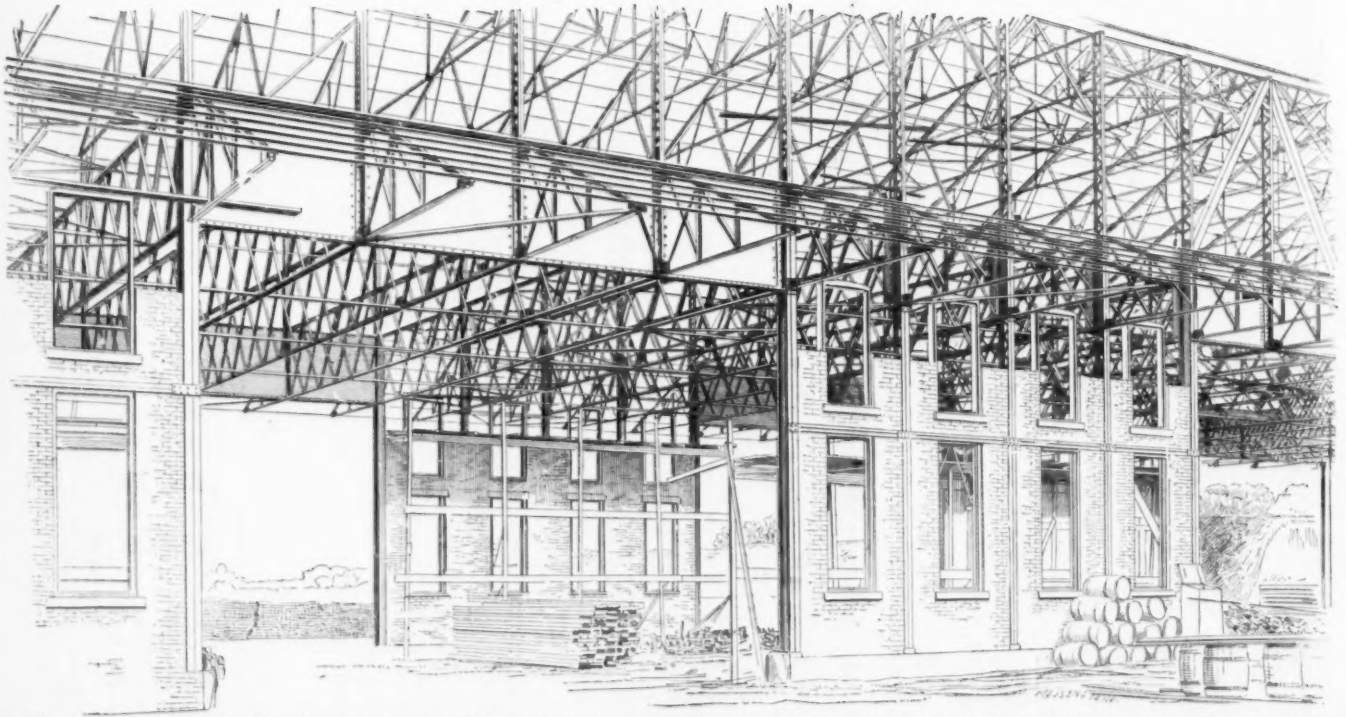

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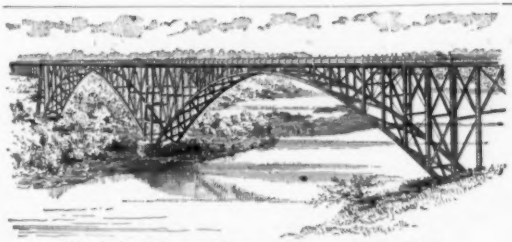

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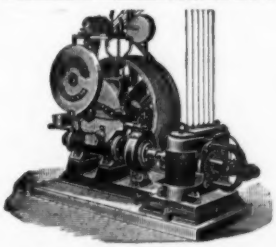

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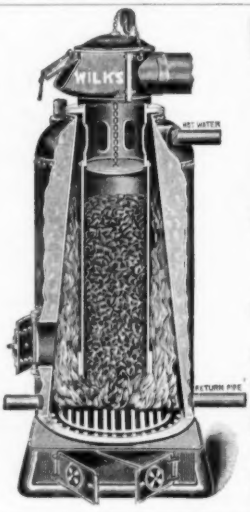

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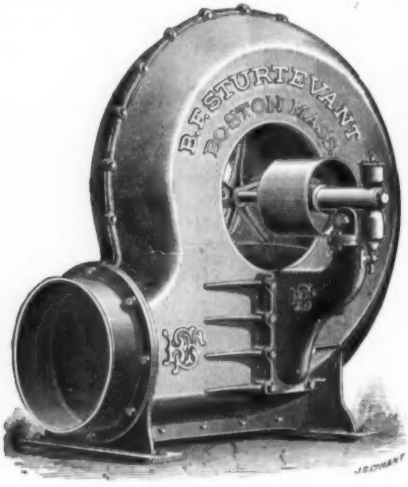

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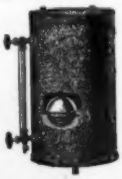

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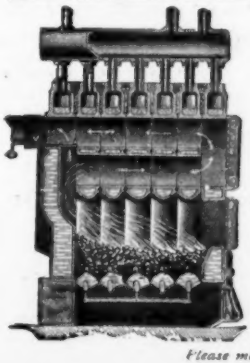

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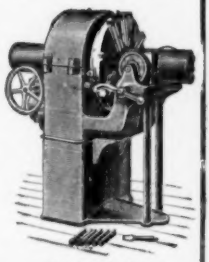
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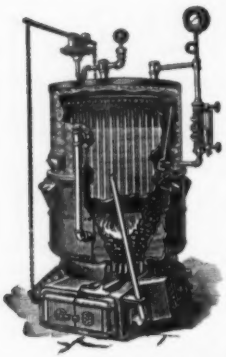

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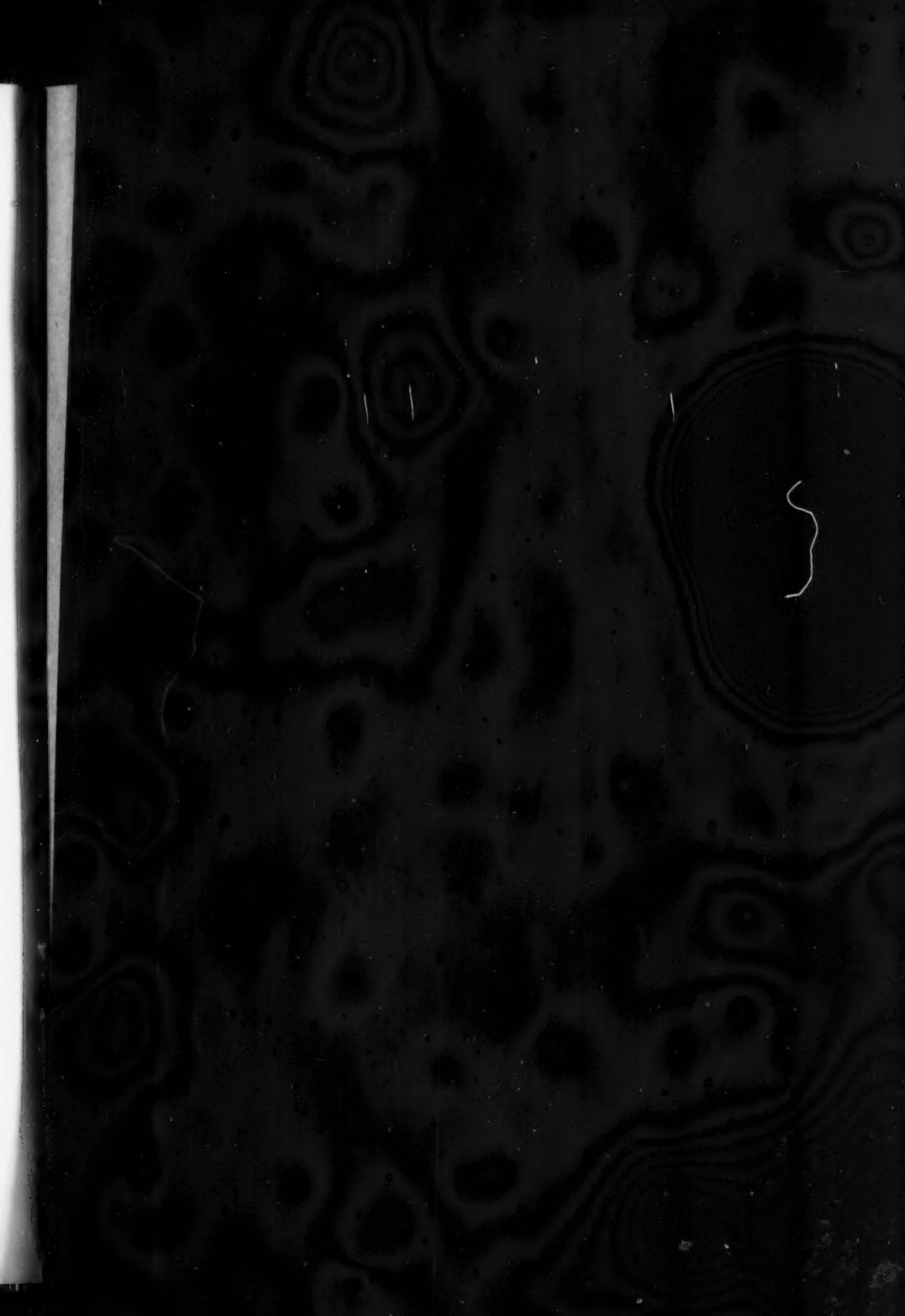

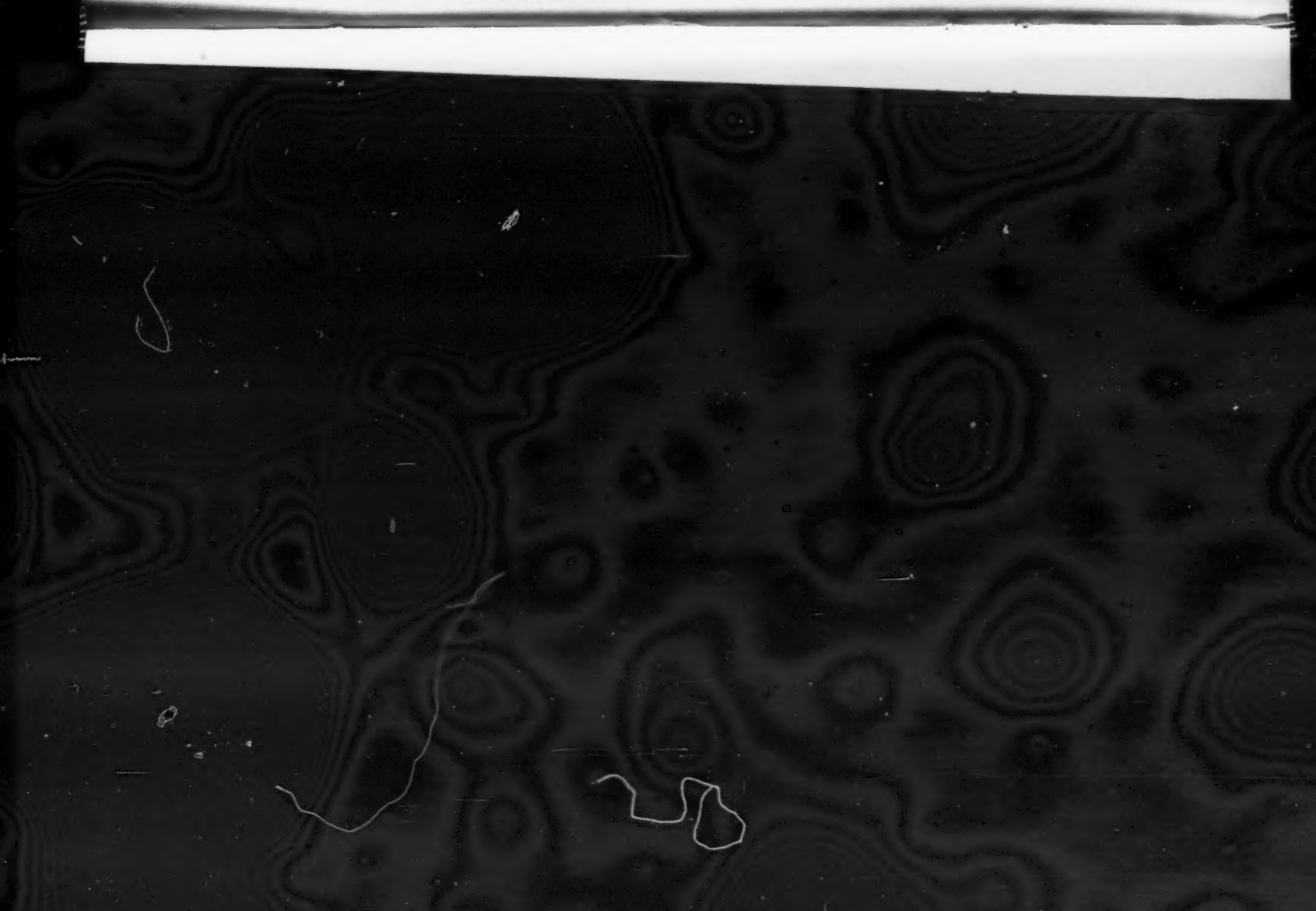

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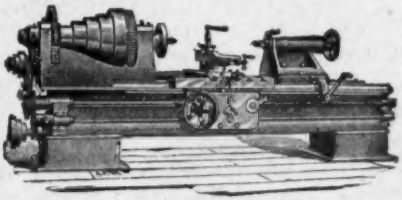

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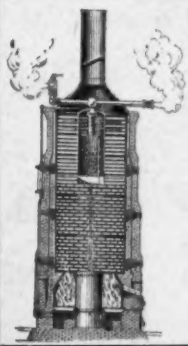

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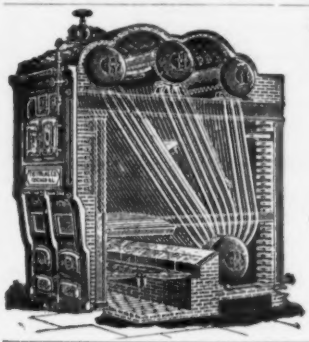

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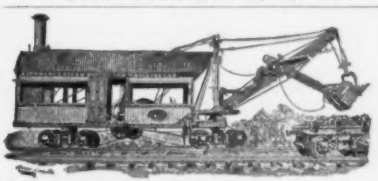

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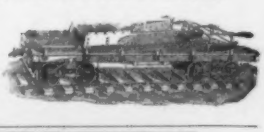

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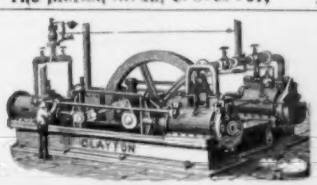

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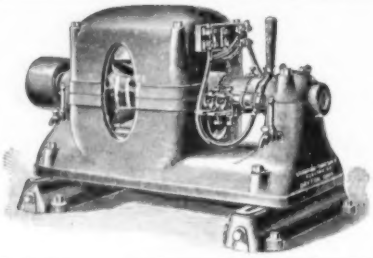

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AUTHORS AND PAPERS THIS MONTH.

HORACE WHITE (*Money and Banking*)—Born in Colebrook, N. H., in 1834; his family soon removed to Wisconsin, and he graduated at Beloit College in 1853; was for many years connected with the Chicago *Tribune*, and from 1864 to 1874 was its editor-in-chief; in 1881 he became one of the editors of the New York *Evening Post;* he has long paid especial attention to financial subjects.

T. A. RICKARD (*Cripple Creek Gold Mines and the Stock Boom*)—Born in 1864 at San Terenzo, Italy; educated at the Royal School of Mines, under Dr. Percy; assistant geologist in the New York Geological Survey; superintendent of important Western mines; a prolific writer on topics of economic geology; is now State Geologist of Colorado, located at Denver.

JAMES MOORE SWANK (*The Future of the American Iron Trade*)—Born in Westmoreland County, Pa.; received an academic, but not a collegiate education; founded the Johnstown (Pa.) *Tribune*, a weekly newspaper, in 1853; in 1871 and 1872 was Chief Clerk of the National Department of Agriculture; since 1872 has been Secretary and since 1885 also General Manager of the American Iron and Steel Association. During these 23 years he has edited all the publications of the association, collected the statistics of the American iron trade, and compiled the statistics of the foreign iron trades. He collected the statistics of iron and steel for the census year 1880.

H. T. NEWCOMB (*Are American Railway Rates too High?*)—Born at Owasso, Michigan, January 4, 1867; fourteen years later graduated from Ludington (Mich.) High School; entered railway service January, 1882, in general offices of Chicago, Milwaukee & St. Paul Railway, then at Milwaukee; March, 1888, accepted position in Bureau of Rates and Transportation of the Interstate Commerce Commission; while in latter employment studied law evenings and was graduated from the Law Department of Columbian University in 1891, receiving degree of L.L. M. from same institution in 1892; in March, 1895, was appointed chief of the freight rate section in the division of Statistics, United States Department of Agriculture; is a member of the bar of the Supreme Court of the District of Columbia and of numerous societies, and a wide contributor to economic and general literature.

CHARLES P. YEATMAN (*An Engineer's Life in the Tropics*)—Graduated at Hughes High School, Cincinnati, O., June, 1872, taking silver medal in mathematics; with Jos. Earnshaw, C.E., Cincinnati, O., Sept. 1, 1872 to Dec. 20, 1872, as rodman, and afterwards resident engineer on the Cincinnati Southern Railway June, 1873, to February, 1877; resident engineer on the Cincinnati & Portsmouth Railroad, May, 1877, to Nov., 1877; assistant engineer, and afterwards chief engineer, on the Antioquia Railway, Colombia, S. A., from Nov. 25, 1877, to Aug. 10, 1883; in charge of survey party on extensions of the Norfolk & Western Railroad from Feb. 1, 1884, to Sept. 22, 1884; chief engineer Girardot Railroad, Colombia, South America, Nov. 29, 1884, to Oct. 1, 1888; resident engineer on the Louisville Southern Railroad, Feb. 6, 1887, to July 12, 1888; assistant engineer on construction of Covington, Ky., reservoir, July 16, 1888, to Jan. 31, 1889; engineer of the Sloss Iron and Steel Co. at Coalburg, Ala., March 11, 1889, to February 1, 1890; locating engineer for Allison, Shafer & Co. from July 7, 1890, to May 8, 1891: U. S. Inspector of brush, stone and pile dike, at Rising Sun, Ind., May 28, 1891, to Oct. 1, 1891, and of riprap on levee at Shawneetown, Ill., Oct. 1, 1891, to April 7, 1892; chief engineer Cucuta Railroad, Colombia, S. A., May 3, 1892, to Nov. 28, 1894.

HENRY FLOY (*Are We Educating too many Electrical Engineers?*)—Born Sept., 1866, at Elizabeth, New Jersey; received the degree of A. B. and M.A. from Wesleyan University, Middletown, Conn., and also the degree of M.E. in electrical engineering from Cornell Univer-

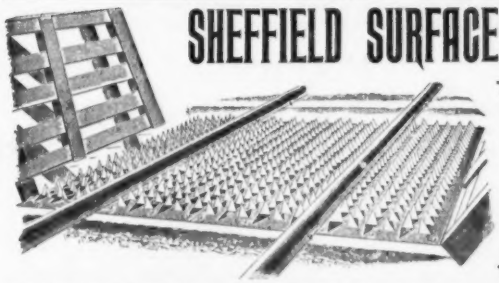
sity; after leaving college entered the Pittsburg factory of the Westinghouse Electric and Manufacturing Co., where he learned practically the details of the electrical manufacturing business; was selected by Supt. Albert Schmid for the writing and publishing of catalogues, books of instruction and descriptive articles, which led to his contribution of frequent and acceptable articles to the various electrical journals on subjects of current interest to the profession; at present in the Engineering Dept. of Westinghouse Electrical and Manufacturing Company.

JOHN B. JOHNSON (*The Location and Construction of Dams*)=Born at Marlboro, Ohio, 1850; graduated at the University of Michigan in 1878 in Civil Engineering; served as U. S. Assistant Engineer on the U. S. Lake Survey and on the Miss. River; professor of civil engineering in Washington University, St. Louis, Mo., since 1883; has planned and superintended the construction of a number of city water works; director of the Washington University Testing Laboratory, where over forty thousand tests of timber have been made under his direction for the U. S. Government; has had charge of the *Index of Current Engineering Literature*, published in the Journal of the Association of Engineering Societies since it started in 1884; has published a number of engineering works, including "Theory and Practice of Surveying," "Modern Frame Structures," and "Engineering Contracts and Specifications"; a member of the Institution of Civil Engineers (London), American Society of Civil Engineers, American Society of Mechanical Engineers, corresponding member of the American Institute of Architects, etc.; has contributed largely to engineering literature, especially on subjects pertaining to the Miss. River and to engineering structures.

BARR FERREE (*Recent Architecture in France*)=Honorary corresponding member of the Royal Institute of British Architects; Membre Correspondant de l'Académie d'Aix-en-Provence; Membre de la Societé de l'Histoire de France, Paris; Member of the Council of the American Society of Church History; Member of the Advisory Board of the Department of Architecture, Brooklyn Institute; 1892-1894 editor of the department of Architecture in THE ENGINEERING MAGAZINE; a frequent contributor to the leading magazines and technical papers on architectural subjects; an honorary corresponding member of the Royal Institute of British Architects—a compliment paid hitherto to only four other Americans, and honorary member of the Académie d'Aix-en-Provence, an important architectural society in France.

FRED. W. TAYLOR (*A Piece-Rate System and Shop Management*)=Prepared for Harvard College at Phillips Exeter Academy in 1874; served his apprenticeship as a pattern-maker, and then as machinist from 1874 to 1878; in the last-named year he began work in the machine shop of the Midvale Machine Company in Philadelphia as a laborer, working his way up as a machinist, clerk, and gang boss, until he became foreman; during this time, finding the need of an engineering education, he studied at night; was admitted to the Stevens Institute of Technology, and, in 1883, after passing all the examinations, received the degree of M. E.; at the Midvale Steel Works he had later the position of master mechanic, in charge of maintenance and repairs, chief draughtsman, and, in 1884, became chief engineer; filled this position until 1890, resigning then to become general manager, for the Manufacturing Investment Company, of two large sulphite pulp mills, one in Madison, Maine, and the other in Appleton, Wisconsin; afterward resigned this position to take up the work of consulting engineer, in which he is now engaged. His specialty is systematizing minor details of manufacturing operations in iron and engineering works and other factories, establishing the best systems of piece work and labor returns, bookkeeping and cost of manufactures.

RICHARD J. HINTON (*Law of Water and Modern Irrigation*)=Born in London, England, November 26, 1830; educated in parochial schools and Mechanics' Institute; attended scientific course at Royal Museum of Geology, and the Workingmen's College, London; learned shorthand; came to the United States early in 1851; learned and worked at the printing trade, and as a reporter and writer; studied topographical engineering in a private school, but pursued newspaper work in New York and Boston; went to Kansas during the Free State troubles as a northern correspondent; traveled extensively in the west; studied law and admitted to the bar, but never practised; connected with railroad and government explorations, had his attention drawn to irrigation by the Mormon settlement in Utah; in the Civil War did special and important service at Washington; returning west was with the Seventh Kansas Cavalry in 1862, and organized the first regiment of colored volunteers,—the first officer mustered in for that purpose; author of a score of volumes, including a "Handbook to Arizona," an early work on Kansas and the Rockies, English Radical Leaders, etc., etc.; his original investigations as an irrigation expert and engineer have been extensive; prepared in 1884-85 the first United States report on that subject, published in 1886; irrigation engineer in U. S. Geological survey, and expert to a Senate committee of investigation; appointed special agent in charge of the artesian and underflow investigation and chief of the irrigation inquiry, Agricultural Department, and prepared four extended personal reports with maps, etc.



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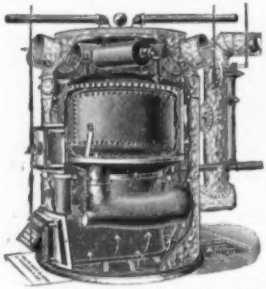

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Alphabetical Index. Page 17.

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M. C. Bullock Mfg. Co., Chicago, Ill.

Fraser & Chalmers, Chicago Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.

Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Dredging Machines.

W. J. Clark & Co., Salem, Ohio.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio
Maryland Steel Co., Sparrows Point, Md.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

Buffalo Forge Co., Buffalo, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Presses.

Merrill Bros., Brooklyn, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.

Dynamos.

Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation Fort Wayne, Ind.
Gates Electric Mfg. Co., Chicago, Ill.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electric Railway Supplies.

Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
Morris, Tasker & Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electrical Instruments.

Bristol Co., Waterbury, Conn.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Gates Electric Mfg. Co., Chicago, Ill.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Queen & Co., Inc., Philadelphia, Pa.
Thresher Electric Co., Dayton, O
Triumph Electric Co., Cincinnati, Ohio.
United Electric Telephone Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
H. K. Porter & Co., Pittsburg, Pa.

Electrical Rubber Goods.

Home Rubber Co., Trenton, N. J.
Spinney, Virtue & Co., Lynn, Mass.

Electroplating and Electrotyping Machines.

Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Emery Wheels.

Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.

Bignall & Keeler Mfg. Co., St. Louis, Mo.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa

Engineering Instruments.

Theo Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Inc., Philadelphia, Pa.

Engine Lathes.

Lodge & Davis Machine Tool Co., Cincinnati, Ohio.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engine Governors.

J. H. McEwen Mfg. Co., Dey St., N. Y.

Engines, Gas, Gasoline, and Petroleum

Otto Gas Engine Works, Philadelphia, Pa.
Pierce Engine Co., Racine, Wis.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.

Engines, Stationary.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Colorado Iron Works, Denver, Colo.
Erie City Iron Works, Erie, Pa.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Maryland Steel Co., Sparrows Point, Md.
Southwark Foundry and Machine Co., Phila., Pa
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robert Wetherill & Co., Chester, Pa.

Evaporators.

Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y

Excavators.

Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Expansion Tanks.

Hepe, Koven & Co., 18 Spruce St., N. Y.

Extensible Sewer Brace.

Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.

Feed-Water Heaters

Edw. P. Allis Co., Milwaukee, Wis.
Goubert Mfg. Co., 14 Church St., N. Y.
Fraser & Chalmers, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Files.

Nicholson File Co., Providence, R. I.

Filters.

Continental Filter Co., 44 Wall St., N. Y.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Fire Department Equipment.
American Ball Nozzle Co., 837 Broadway, N. Y.

Fireproof Building Material.
Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Empire Fire Proofing Co., Pittsburg, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
James L. Foote, Slatington, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Maryland Steel Co., Sparrows Point, Md.
Milton Mfg. Co., Milton, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Translucent Fabric Co., Boston, Mass.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co. Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Flexible Shafts.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.
T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Foot and Hand Presses.
Toledo Machine & Tool Co., Toledo, Ohio.

Forges.
Buffalo Forge Co., Buffalo, N. Y.

Forgings.
Toledo Machine & Tool Co., Toledo, Ohio.

Furnace Builders.
Fraser & Chalmers, Chicago, Ill,
Julian Kennedy, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.

Furniture.
The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.
J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure, Steam, Water, etc.
Bristol Co., Waterbury, Conn.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.

Gas Works Machinery.
Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.
U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Continental Iron Works, Brooklyn, N. Y.
Crane Company, Chicago, Ill.
Jenkins Brothers, 71 John St., N. Y.
The Fairbanks Co., New York.

Gear Cutters.
Brown & Sharpe Mfg. Co., Providence, R. I.
Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing.
Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dayton Globe Iron Works Co., Dayton, Ohio.
New Process Rawhide Co., Syracuse, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.
Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grading Machines.
F. C. Austin Mfg. Co., Chicago, Ill.

Grain Elevator Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates.
Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Grips, Cable Railways.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hand Cars.
Sheffield Car Co., Three Rivers, Mich.

Hangers.
SEE PULLEYS, ETC.

Hardware Manufacturers.
Charles H. Besly & Co., Chicago, Ill.
Merrill Bros., Brooklyn, N. Y.
L. S. Starrett, Athol, Mass.

Heating and Ventilating Apparatus.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.
American Boiler Co., Chicago, Ill.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
S. Wilks Mfg. Co., Chicago, Ill.

Hoisting Engines and Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
Brown Hoisting & Conveying Mch. Co., Cleve'nd, O.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio
Webster, Camp & Lane Machine Co., Akron, Ohio.

Hod Hoisting Machinery.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Hollow Bricks.
Empire Fire-Proofing Co., Pittsburg, Pa.
Henry Maurer & Son, 420 E. 23d St., New York.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.

Hydraulic Machinery.
Fraser & Chalmers, Chicago, Ill.
New York Belting & Packing Co., Ltd., New York.
Maryland Steel Co., Sparrows Point, Md
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.
Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.
Queen & Co., Inc., Philadelphia, Pa.

Injectors.
American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.
G. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire
W. R. Brixey, 203 Broadway. N. Y.
Eastern Electric Cable Co., Boston, Mass.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Insulating Paper.
Standard Paint Co., 2 Liberty St., N. Y.

Iron Working Machinery.
Charles H. Besly & Co., Chicago, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Merrill Bros., Brooklyn, N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Joists, Iron and Steel.
Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Kyanizing.
Otis Allen & Son, Lowell, Mass.

Lamps, Electric.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.
Bradford Mill Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Lead Corroders.
Harrison Bros. & Co., Philadelphia, Pa.

Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
Pittsburg Locomotive Works Pittsburg, Pa.
H. K Porter & Co., Pittsburg, Pa.
Thomas Carlin's Sons, Allegheny, Pa,

Locomotive Brakes.
Westinghouse Air Brake Co., Pittsburg, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Lubricants.
Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.
Sherwood Mfg. Co., Buffalo, N. Y.

Lumber and Shingles.
Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Machine Screws, etc.
Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.
Armstrong Bros. Tool Co., Chicago, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Charles H. Besly & Co., Chicago Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio,
Long & Allstatter Co., Hamilton, Ohio
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Merrill Bros., Brooklyn, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Marine Machinery.
W. A. Crook & Bros Co., Newark, N. J.
Marine Iron Works, Chicago, Ill.

Mathematical Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Inc., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Merchant Steel.
Wm. Jessop & Sons, Limited. 91 John St., N. Y

Metal Punching and Shearing.
Harrington & King Perforating Co,, Chicago, Ill.

Metallurgical Supplies.
Colorado Iron Works, Denver, Colo.

Meters, Electric.
Fort Wayne Electric Corporation, Fort Wayne, Ind.

Meters, Water.
Deane Steam Pump Co., Holyoke, Mass.

Milling Machines.
Brown & Sharpe Mfg. Co., Providence, R. I.
Ingersoll Milling Machine Co., Rockford, Ill.
Lodge & Davis Machine Tool Co., Cincinnati, Ohio.

Mine Cars
Colorado Iron Works, Denver, Colo.

Mining Machinery
Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
Colorado Iron Works, Denver, Colo.
W. A. Crook & Bros. Co., Newark, N. J.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N.
Jeffery Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Mining Screens.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.
Eddy Electric Manufacturing Co., Windsor, Conn,
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Gates Electric Mfg. Co., Chicago, Ill.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa

Nickel.
Canadian Copper Co., Cleveland, O.

Nut Locks
Eureka Nut Lock Co., Pittsburg, Pa.

Oil Cups.
Sherwood Mfg. Co., Buffalo, N. Y.

Ore Roasting Machinery.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.

Ornamental Iron Work.
Winslow Bros. Co., Chicago, Ill.

Packing.
The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Jenkins Brothers, 71 John St., N. Y.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Sherwood Mfg. Co., Buffalo, N. Y.

Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Joseph Dixon Crucible Co., Jersey City, N. J.
Harrison Bros. & Co., Philadelphia, Pa.
Standard Paint Co., 2 Liberty St., N. Y.

Paints (Special for Iron.)
SAME AS ABOVE.

Paper Mill Machinery.
Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Penstocks.
Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds).
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.
Rochester Optical Co., Rochester, N. Y.

Pipe, Cast Iron.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
Jeanesville Iron Works, Jeanesville, Pa.
Charles Millar & Son, Utica, New York.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.
National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.
A. Wyckoff & Son, Elmira, N. Y.
Manville Covering Co., Milwaukee, Wis.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Pipe Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn
Bignall & Keeler Mfg. Co., St. Louis, Mo.

Pipe, Sewer.
Charles Millar & Son, Utica, New York.
Union Sewer Pipe Co., Akron, Ohio.

Pipe, Wrought Iron, Line and Drive.
Crane Company, Chicago, Ill.
Morris, Tasker & Co., Philadelphia, Pa.

Planing Mill Machinery.
J. A. Fay & Egan Co., Cincinnati, Ohio.
G. B. Rogers & Co., Norwich, Conn.

Plating Materials.
Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Portable Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Power Punches and Shears.
Long & Allstatter Co., Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio

Preservation of Lumber.
Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic.
Maryland Steel Co., Sparrows Point, Md.
Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Pressure Regulators.
The Fairbanks Co., New York.
Van Auken Steam Specialty Co., Chicago, Ill.

Prospecting Drills.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulley Lathes.
Fitchburg Machine Works, Fitchburg, Mass.

Pulleys, Shafting and Hangers.
Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

Pulverizers.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Fraser & Chalmers, Chicago, Ill.

Pumps and Pumping Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Colorado Iron Works, Denver, Colo.
Connersville Blower Co., Connersville, Ind.
Cook Well Co., St. Louis, Mo.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Fraser & Chalmers, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeanesville Iron Works, Jeanesville, Pa.
John H. McGowan Co., Cincinnati, Ohio.
New York Air Brake Co., 66 Broadway, N. Y.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Punching and Shearing Presses.
Long & Allstatter Co., Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Quarrying Machinery.
M. C. Bullock Mfg. Co., Chicago, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiator Screens.
Harrington & King Perforating Co., Chicago, Ill.

Radiators.
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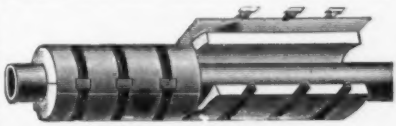

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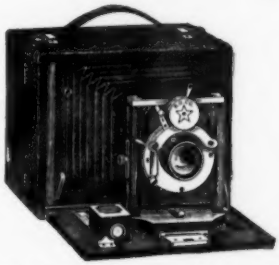

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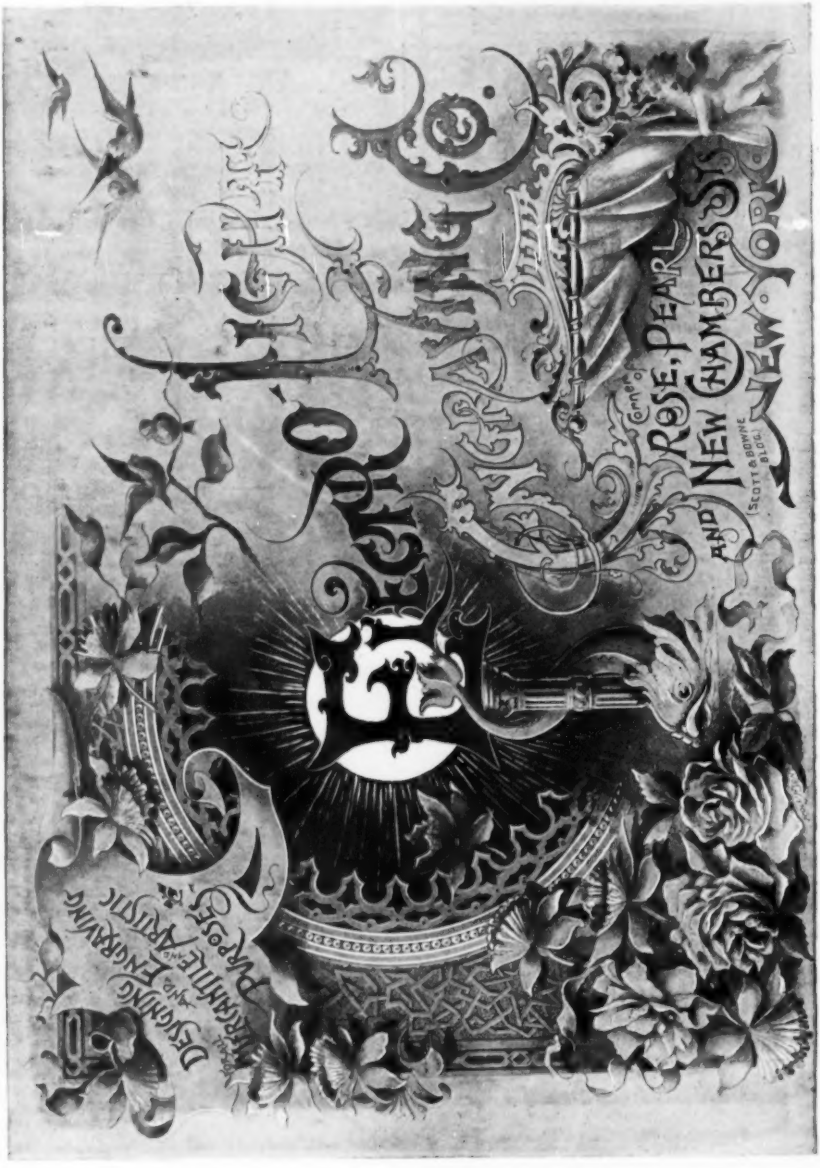
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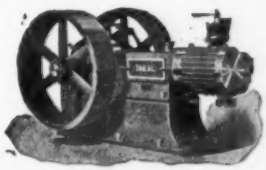

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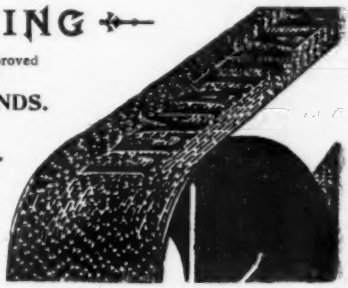

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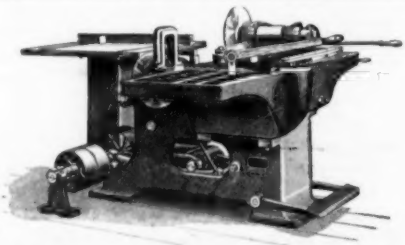

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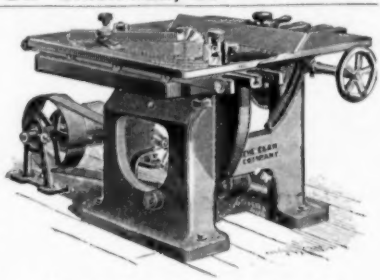

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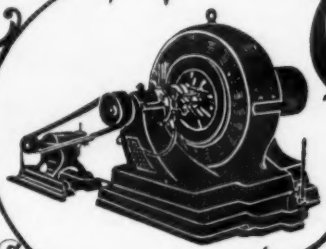

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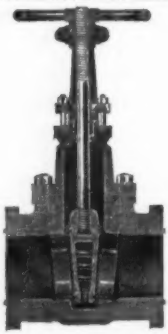

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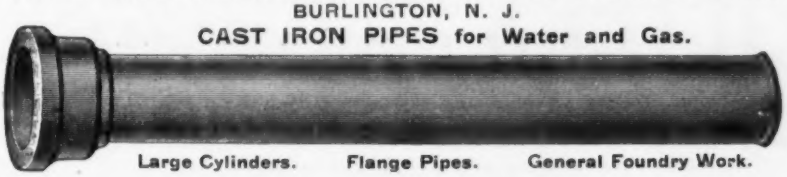

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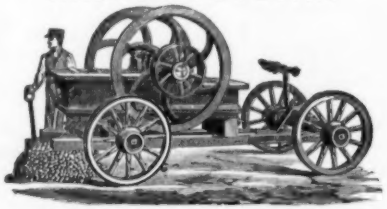

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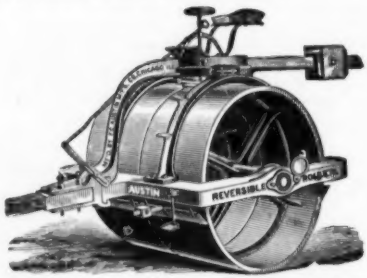

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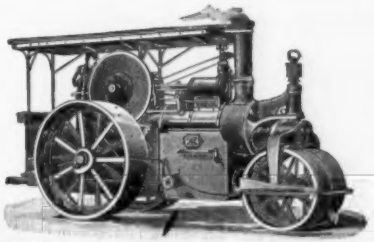

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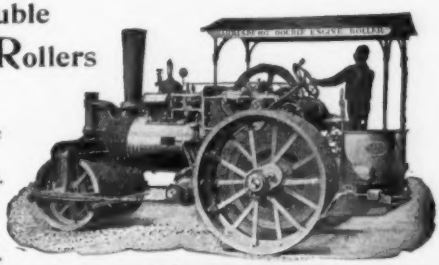

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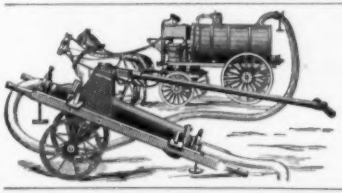

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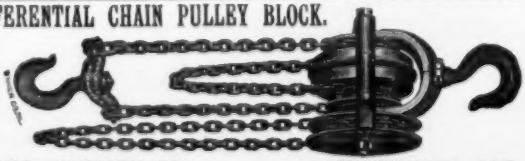

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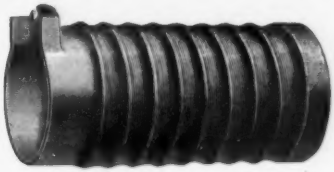

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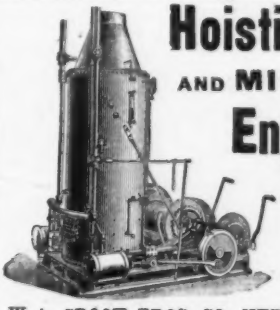

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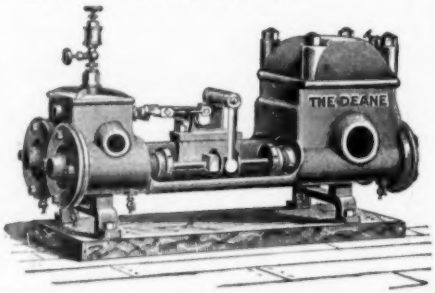

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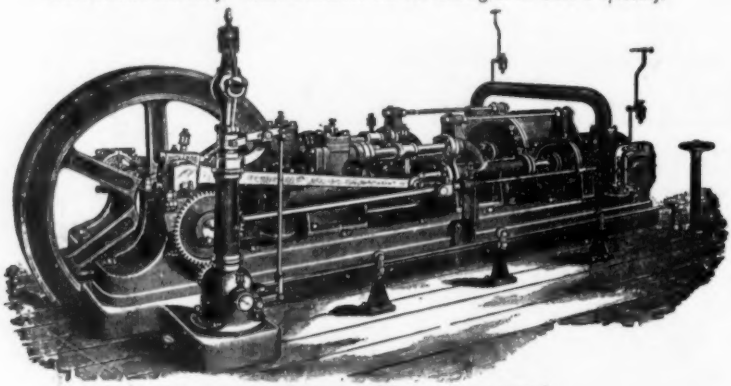

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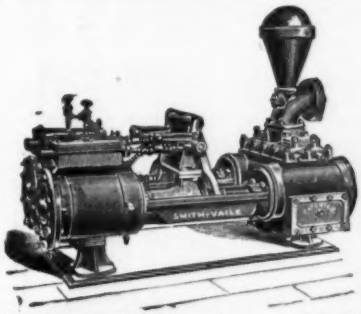

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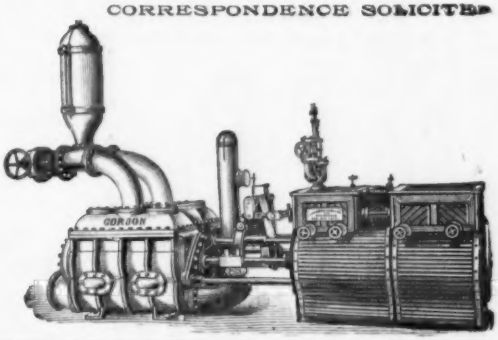

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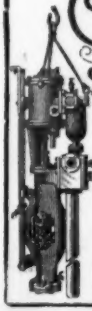

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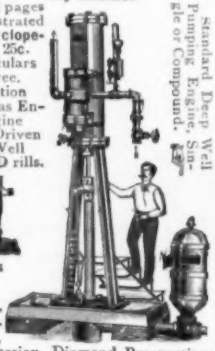

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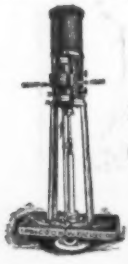

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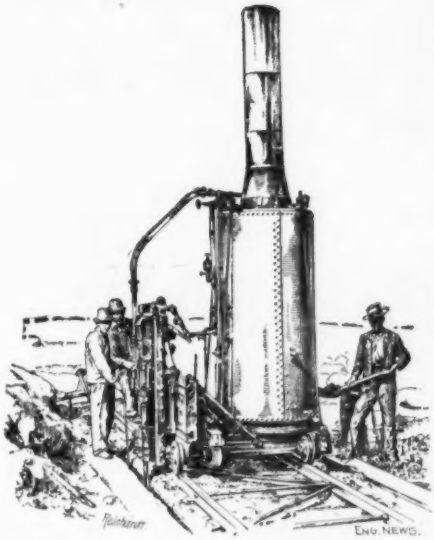

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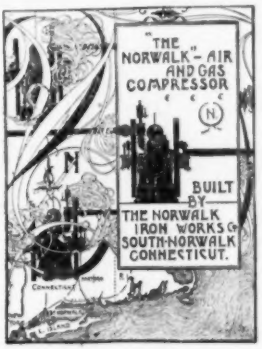

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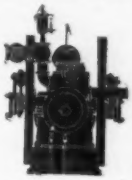

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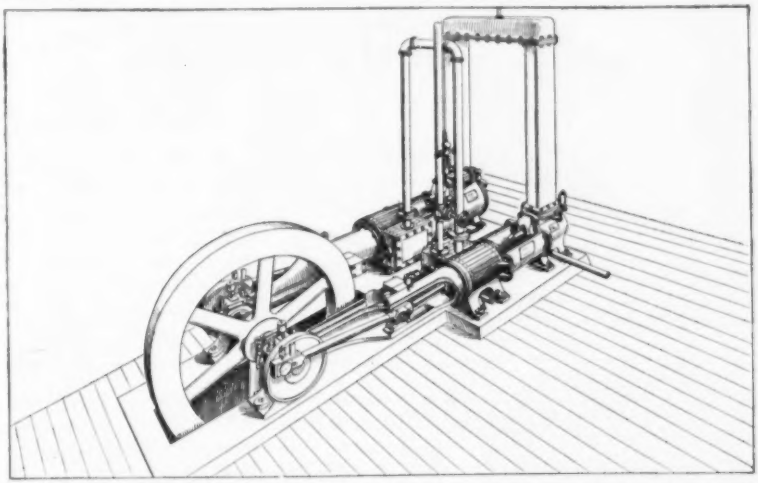

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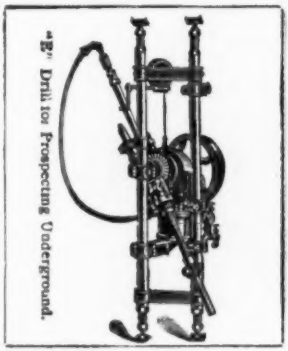
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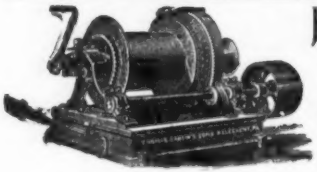
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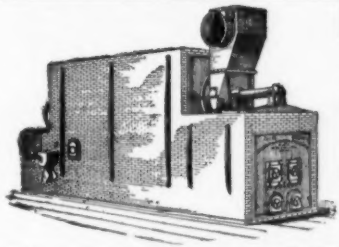

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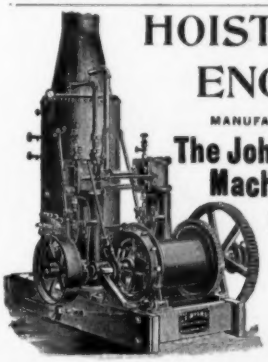

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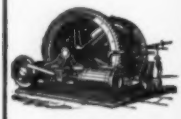

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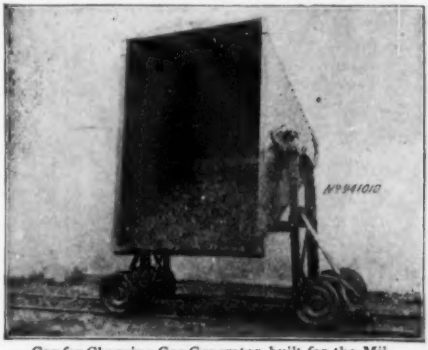

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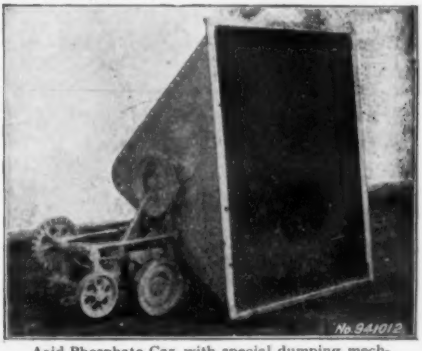

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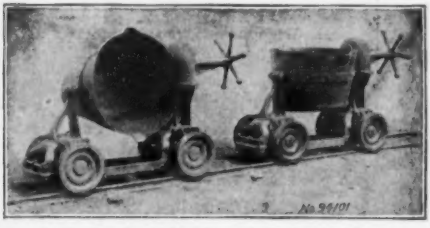

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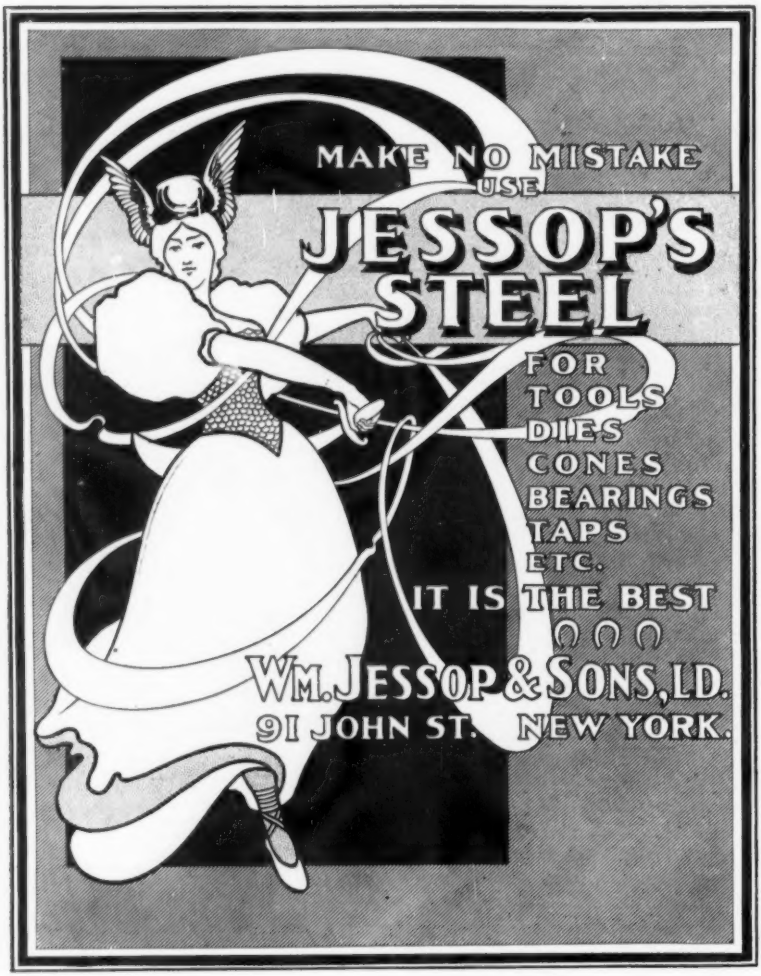

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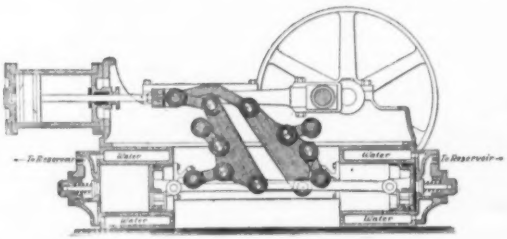

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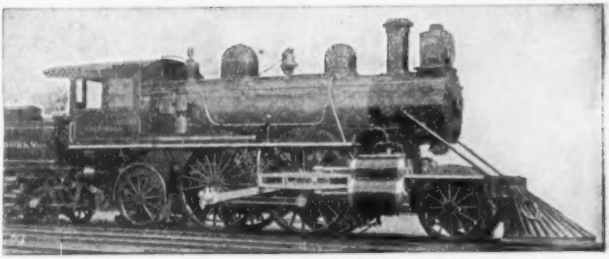

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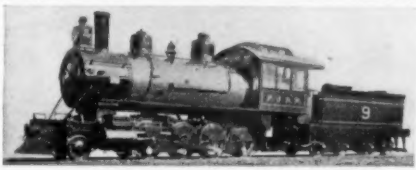

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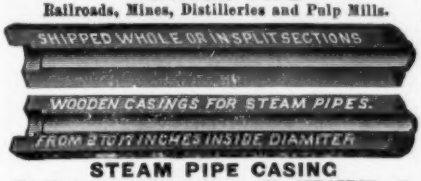

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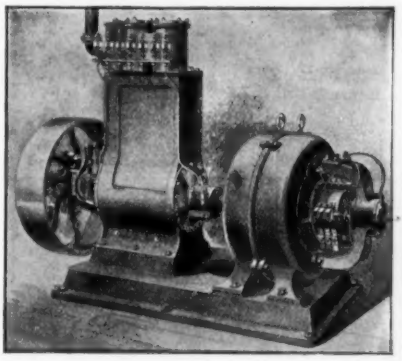

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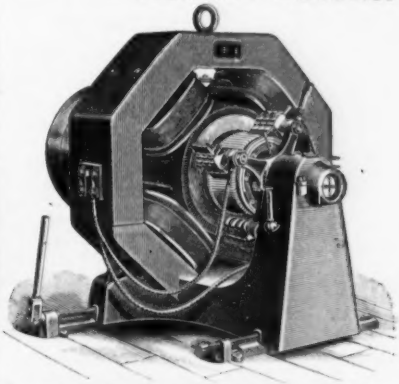

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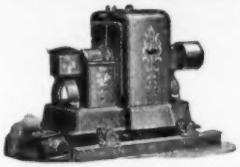

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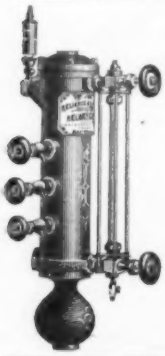

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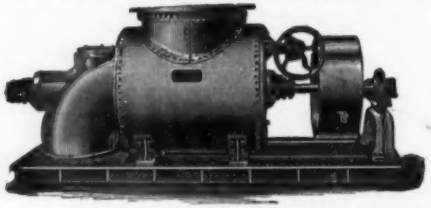

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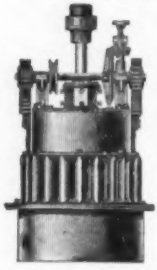

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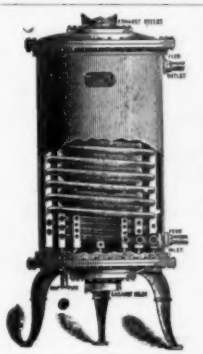

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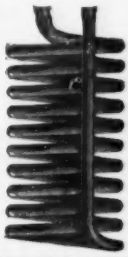

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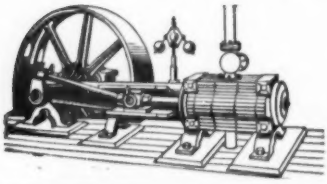

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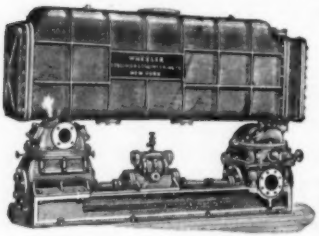

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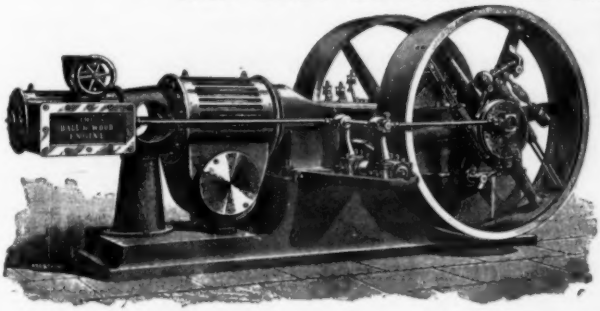

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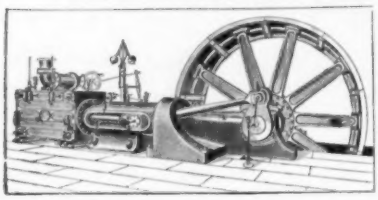

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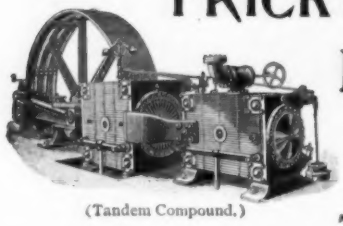

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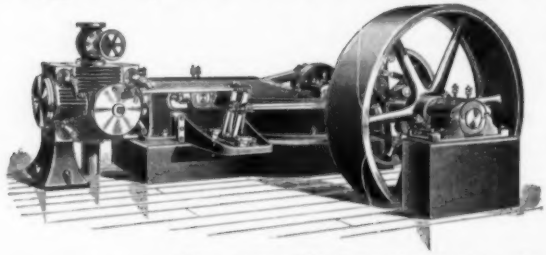

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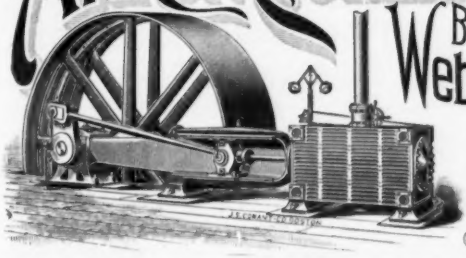

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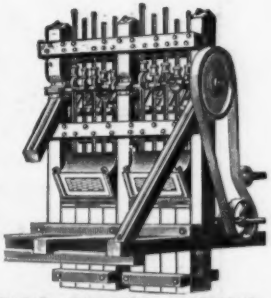

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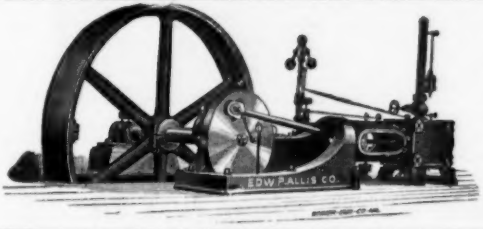

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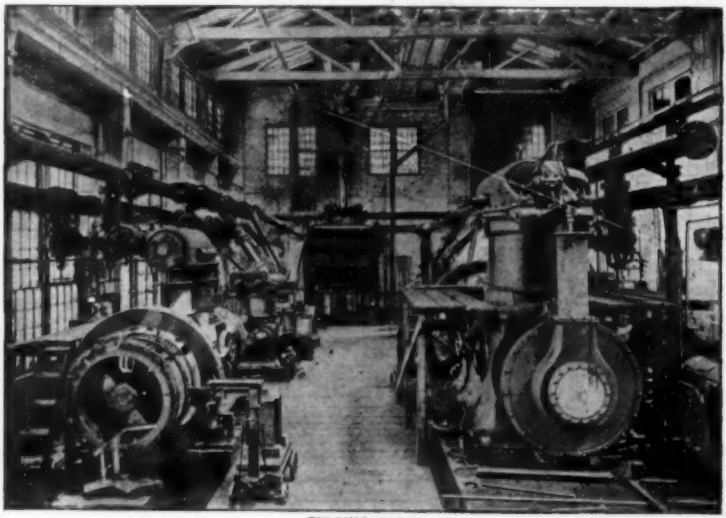

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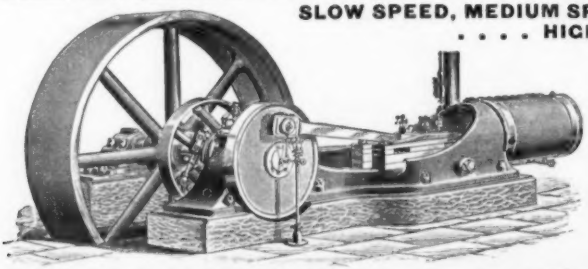

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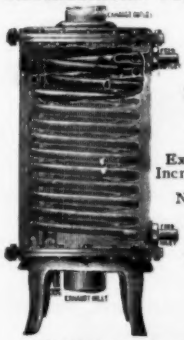

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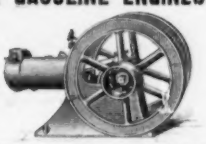

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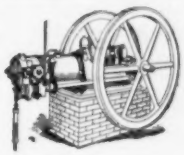

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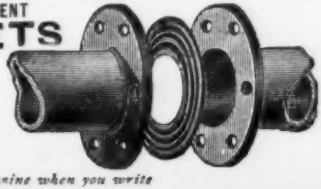

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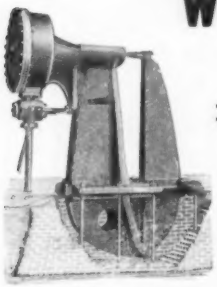

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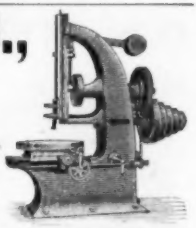

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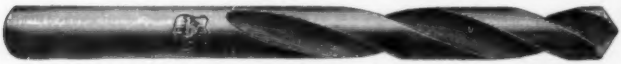

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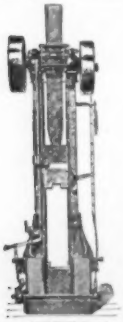

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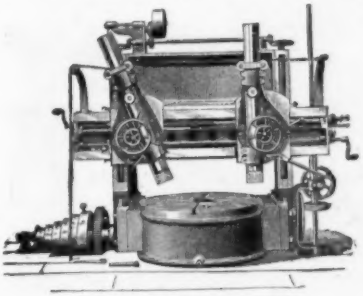

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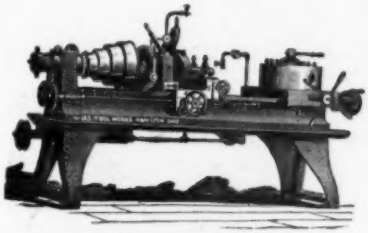

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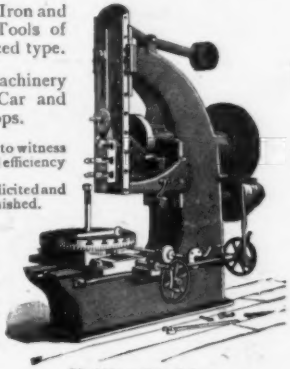

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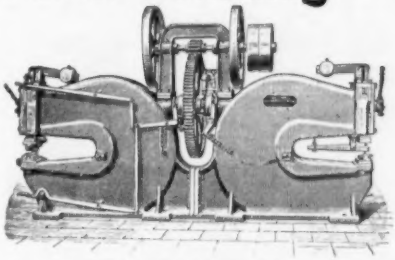

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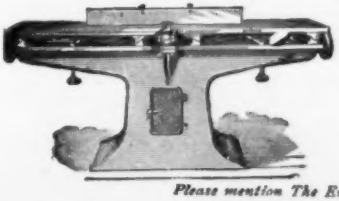

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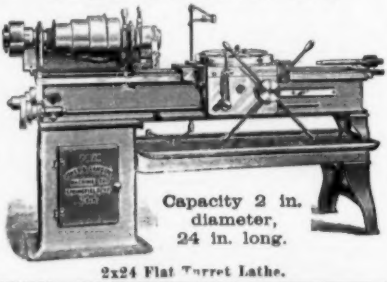

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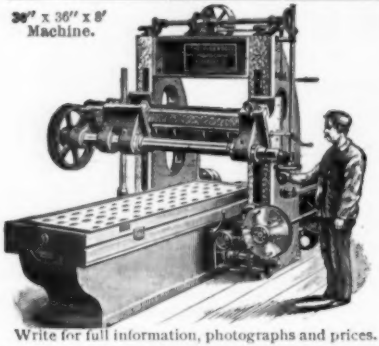

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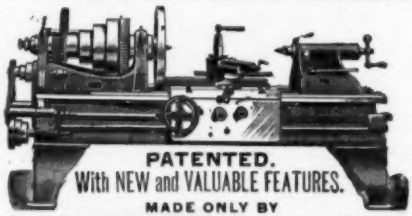

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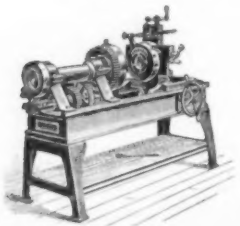

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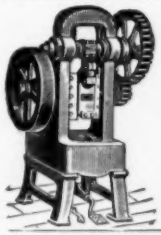

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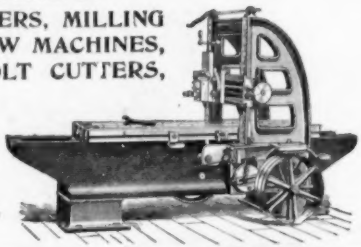

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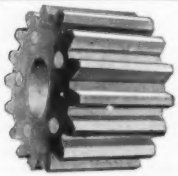

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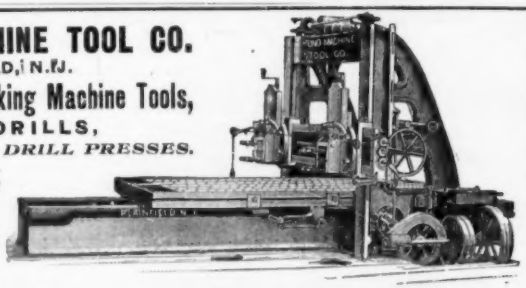

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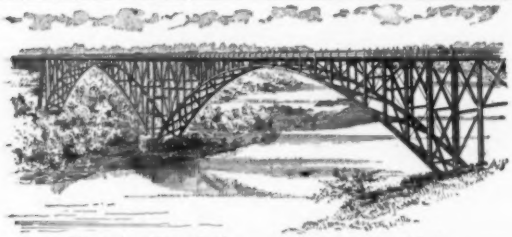

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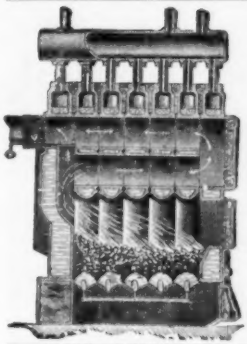

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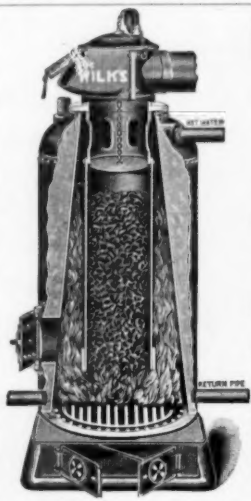

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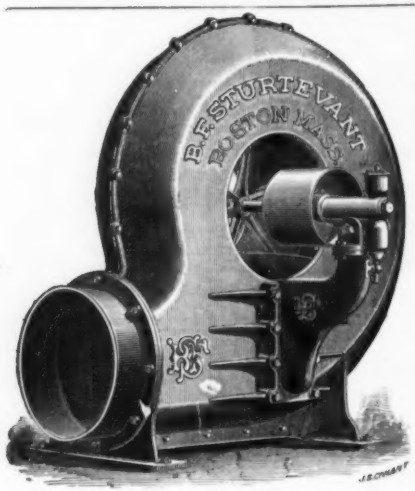

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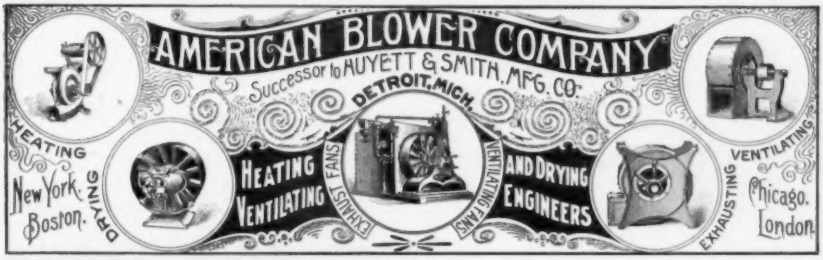

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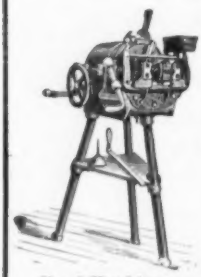
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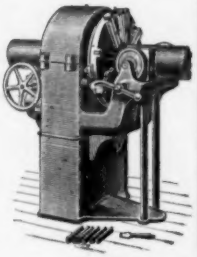
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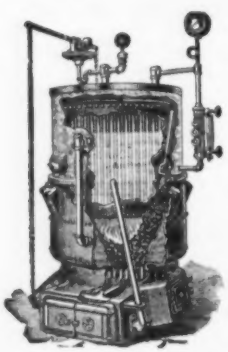

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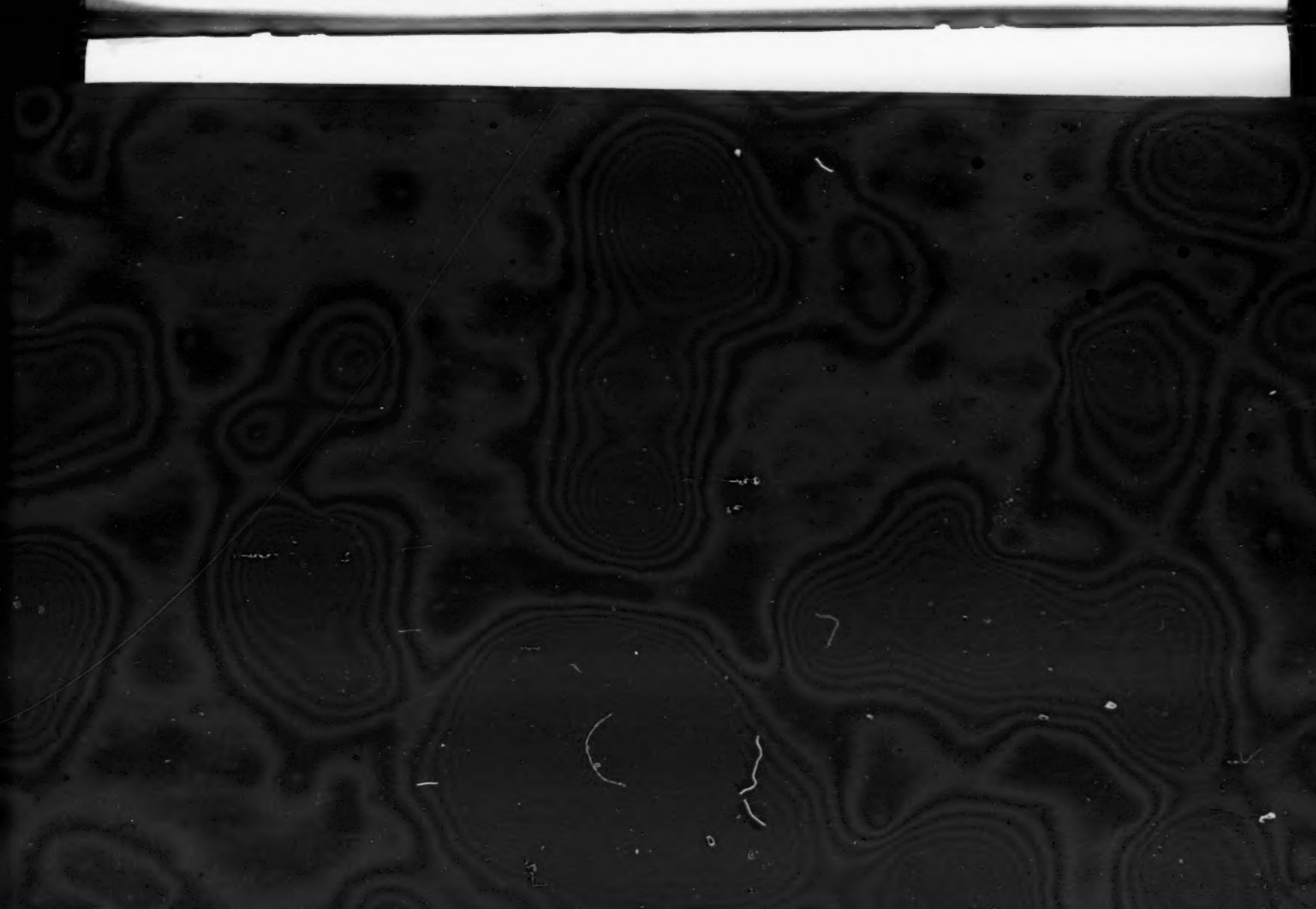

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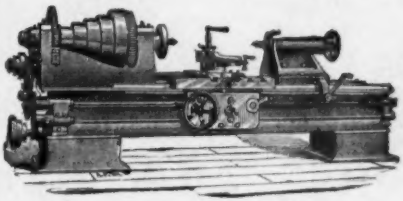

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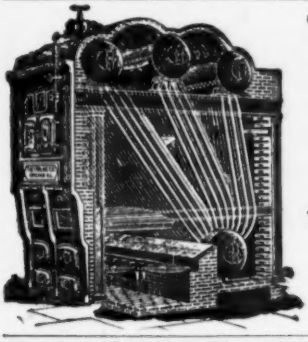

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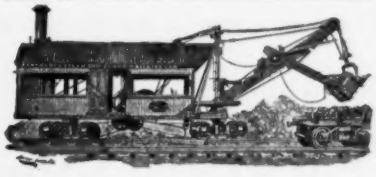

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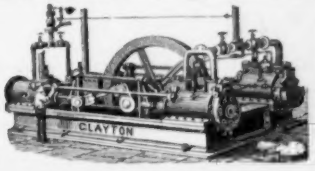

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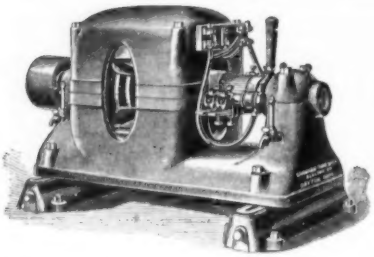

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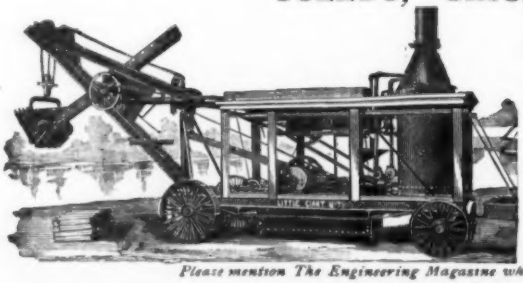

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AUTHORS AND PAPERS THIS MONTH.

EDWARD ATKINSON (*Jingoism, or The War upon American Industry*)=Born at Brookline, Mass.; a profound student of economics, of finance, and of commercial polity; has written with authority and influence upon many topics relating to these subjects, and his contributions have appeared in the foremost periodicals in the United States; has given much attention to construction of slow-burning buildings, to factory construction, and insurance; is a pronounced monometallist, and a strong opponent of the silver-policy that some have recently sought to force upon the government. In the present paper, as its title indicates, Mr. Atkinson considers the recent and present war feeling as a direct injury to our industry and commerce, and as excited by an inadequate cause.

E. M. AMORES (*The Trade and Industry of South America*)=The Cuban gentleman who contributes the article which we publish in this issue under the above title has been a resident of this city for many years and has a thorough American collegiate education, being well known as a scholar in his own as well as in the English language. Mr. Amores' Americanism is also well known, and being in favor of our securing more intimate commercial relations with Latin America, he has made a careful study of the great natural resources of these countries and of the magnificent opportunities which their markets afford to American capitalists, American skill, and American enterprise.

HENRY B. C. NITZE (*Gold Mining in the Southern States*)=Born April 19, 1867, in Baltimore, Md.; entered Lehigh University School of Mines in 1883, from which he graduated in 1887 with degree of B. Sc.; remained one post-graduate year and took degree of E. M. in 1888; spent remainder of that year and 1889 in the west, at the Ontario and Daly mines in Utah, and the Anaconda smelter in Montana, respectively; during 1890 engaged in the Birmingham, Ala., district, in chemical engineering and geological work; since 1891 connected with the Geological Survey of North Carolina, and engaged in occasional private consulting work; member of the American Institute of Mining Engineers since 1888; member Geological Society of Washington.

BURTON ELLINWOOD GREENE (*The Commercial Exploitation of Electricity*)=Born in McGrawville, Cortlandt Co., N. Y.; a lineal descendant of Dr. John Greene, of Salisbury, Eng., who came to America, and stood next to Roger Williams in establishing the Rhode Island colony; educated at Allegheny College, Meadville, Pa.; subsequently learned the printers' trade in the office of the Newark (N. Y.) Union, and worked on many of the leading daily papers of the country, including the *Chicago Times*, *Buffalo Courier*, *New York Tribune*, *Journal of Commerce*, and the *Evening Post;* assisted in establishing what is now the *Lyons Sentinel*, Lyons, N. Y.; associated for some time with Mrs. Martha J. Lamb in the conduct of the *Magazine of American History;* in January, 1892, became business manager of *Electricity*, and in September of the same year acquired complete control of that publication, and became one of its editors, retiring from this publication Jan. 1, 1896; he has made a thorough study of the commercial side of electricity, and is a most competent authority on the subject.

GEORGE RICHMOND (*Limits and Possibilities of the Gas Engine*)=Mechanical Engineer; has acted for several years as patent expert to the De La Vergne Refrigerating Machine

Company, and now has charge of the department of gas and oil engine manufacture in the same establishment. Has written not profusely, but very acceptably for technical journals, including this magazine. Member of the American Society of Mechanical Engineers.

WILLIAM L. DERR (*The Railroad Accident and Emergency Service*) = Born at Charlestown, Md., 1857; educated in private and public schools in Havre de Grace, Md., and took a special course at the Polytechnic School of the State of Pennsylvania, Philadelphia; studied civil engineering in the office of the late Edw. Larkin, engineer, Susquehanna Bridge, Havre de Grace, 1873 to 1877; maintenance of way department, P. C. & St. L. Ry., as assistant engineer, and as supervisor until 1882; on N. Y. & N. E. R. R., as engineer, roadmaster and assistant to superintendent until 1886; then with Erie R. R., as roadmaster; at present division superintendent same road.

DANIEL W. MEAD (*Locating a Water Supply*) = Born at Fulton, N. Y. 1862; received preparatory education at Rockford public schools and private instruction; graduated from Cornell University department of civil engineering, 1884; topographer with United States Geological Survey under Prof. T. C. Chamberlain, 1884-85; city engineer, Rockford, Ill., 1886-88; since 1888, consulting and constructing engineer on municipal public works, also general manager of Rockford Construction Co., and secretary and treasurer of the National Clay Co.; member of the American Society of Civil Engineers, American Institute of Mining Engineers, Western Society of Engineers, American Public Health Association, American Water Works Association, Illinois Society of Engineers and Surveyors, and National Brick Manufacturers Association; president of the Illinois Society of Engineers and Surveyors 1894-1895; first vice-president Western Society of Engineers, 1894; has been a contributor to the transactions of the various societies of which he is a member, and also to the technical press on subjects of water supply and pavements.

RUSSELL STURGIS, A. M., Ph. D., F. A. I. A., (*Architectural Sculpture in the United States*) = A resident of New York city and a well-known architect and writer on fine arts; art editor of *The Nation* for several years; member of executive committee of the Metropolitan Museum of Art; trustee and first secretary of the American Institute of Architects; professor of the Fine Arts in the College of the City of New York; editorial contributor to the Century Dictionary for decorative art, medieval archæology, etc.; editor for the fine arts of Webster's International Dictionary, and for the new edition of Johnson's Universal Cyclopedia; lecturer on fine arts at Columbia College and the Metropolitan Museum; past president of the Architectural League, of New York; vice president of the National Sculpture Society; president of the Fine Arts Federation of New York; member of the Avery Memorial Library Commission. Mr. Sturgis is one of the most distinguished and capable architectural writers now living, combining, as he does, an honorable and active professional career with broad learning, discriminating criticism, and a profound appreciation of art in all its forms.

PETER VEDEL (*The Free-port of Copenhagen*) = Born in Denmark 1862; graduated from the Copenhagen Polytechnic School as a C. E.; worked one year in an engineering office in London; for four years assistant engineer to the Copenhagen Harbor administration; was awarded a second prize by the Danish government for his design to the new Free-port, with the works of which he became connected; was for two years assistant to the renowned Dutch engineer J. A. A. Waldorp, chief engineer of the Dutch Waterstaat, on the harbor works of La Plata at Ensenada in the Argentine republic; has for several years been engaged on professional work in Chicago, Ill., where he now resides.

W. C. DODGE (*The Stubborn Opposition to Inventors*) = Born in Solon, Cortlandt Co., N. Y., in 1827; received a common school education; then attended a private school, and afterward the Ithaca Academy; at age of sixteen engaged in teaching; in 1846 went to Wisconsin (then a territory and helped to establish a newspaper of which he became joint proprietor and editor; began study of law in 1849; admitted to the bar in 1851; shortly after took charge of the *Winona Republican*, but sold out his interest in 1858, and established a newspaper at St. Peter, Minn.; in 1860 was appointed doorkeeper of the House of Representatives, and in 1864 was appointed an examiner in the U. S. Patent Office; in 1884 he invented a successful machine for loading cartridges; established business as patent solicitor in 1864, and has practiced since as expert in courts and in many of the most important patent litigations; one of the judges of awards at the World's Fair at Chicago; member of American Association for the Advancement of Science; member of committee on Patent Legislation of the American Association of Inventors and Manufacturers.

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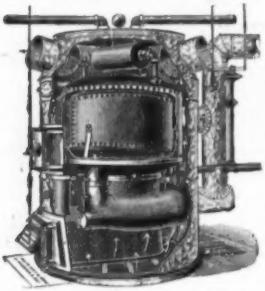

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Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
C. B. Rogers & Co., Norwich, Conn.
J. A. Fay & Egan Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co , Providence, R. I.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
McNeal Pipe and Foundry Co., Burlington, N. J.
Middletown Car Works, Middletown, Pa
Ohio Pipe Co., Columbus, Ohio.
Riter & Conley, Pittsburg, Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.
R. D. Wood & Co., Philadelphia, Pa.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Philadelphia, Pa.

Chemical Works Machinery.

Fraser & Chalmers, Chicago, Ill.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Clay Working Machinery.

W. J. Clark & Co., Salem, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Closets.

Standard Manufacturing Co., Pittsburg, Pa.

Clutches, Friction.

J. S. Mundy, Newark, N. J.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Coal Mining Machinery.

Buffalo Forge Co., Buffalo, N. Y.
W. J. Clark & Co., Salem, Ohio.
W A Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
C. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Concentrators and Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Sturtevant Mill Co., Boston Mass.

Condensers, Jet.

Deane Steam Pump Co., Holyoke, Mass.

Condensers, Surface.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y

Consulting Engineers.

Alton D. Adams, Worcester, Mass.
D. Ashworth, Pittsburg, Pa.
Wm. H. Bryan, St. Louis, Mo.
C. M. Conradson, Madison, Wis.
E. L. Corthell 71 Broadway, New York.
Henry C Eddy, Chicago, Ill.
Dr. Willis E. Everette, Tacoma, Wash.
M. Fargusson, Southport, N. C.
C. T. Gooding, Tucson, Ariz.
E. B. Hussey, Seattle, Wash.
E. P Jennings, Ironwood, Mich.
Julian Kennedy, Pittsburg, Pa.
A. L. McRae, Austin, Texas.
Frank Nicholson, Phoenix, Ariz.
Pittsburg Testing Lab'y, Ltd., Pittsburg, Pa.

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BUYERS' DIRECTORY

Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
Vandenbergh Lab'y of Chem. Ind., Buffalo, N. Y.
Wm. O. Webber, Boston, Mass.

Contractors' Dump Cars, etc.

Gates Iron Works, Chicago, Ill.
Middletown Car Works, Middletown, Pa.
Sheffield Car Co., Three Rivers, Mich.

Contractors' Supplies

Thomas Carlin's Sons, Allegheny, Pa.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.

Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
W J. Clark & Co , Salem, Ohio.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link-Belt Engineering Co., Phila., Pa.

Copper.

Canadian Copper Co., Cleveland, O.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Wheeling Corrugating Co., Wheeling, W. Va.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
Earle C. Bacon 26 Cortlandt St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co,. Philadelphia, Pa.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Crushers, Ore, Phosphate, Rock.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Earle C. Bacon, 26 Cortlandt St., N. Y.
F. M. Davis Iron Works, Denver, Col.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Sturtevant Mill Co., Boston, Mass.

Diamond Drills.

M C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.

Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Dredging Machines.

W. J. Clark & Co., Salem, Ohio.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point. Md.
New York Dredging Co., 61 Park Row, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

Buffalo Forge Co., Buffalo, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Presses.

Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co , Sparrows Point, Md.

Dynamos.

H. B Coho & Co., 203 Broadway, New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Gates Electric Mfg. Co., Chicago, Ill.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
J. H. McEwen Mfg. Co., Dey St , N. Y.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Machinery and Supplies.

Bristol Co., Waterbury, Conn.
H. B. Coho & Co., 203 Broadway, New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Gates Electric Mfg. Co., Chicago, Ill.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Morris, Tasker & Co., Philadelphia, Pa.
Queen & Co., Inc., Philadelphia, Pa.

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Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
United Electric Telephone Co., Chicago,
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
H K. Porter & Co., Pittsburg, Pa.

Electroplating and Electrotyping Machines.

Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Emery Wheels.

Manhattan Rubber Mfg Co., 61 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.

Bignall & Keeler Mfg. Co., St. Louis, Mo.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Inc., Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engine Governors.

J. H. McEwen Mfg. Co., Dey St., N. Y.

Engines, Gas, Gasoline, and Petroleum.

Otto Gas Engine Works, Philadelphia, Pa.
Pierce Engine Co., Racine, Wis.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.

Engines, Stationary.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Colorado Iron Works, Denver, Colo.
Erie City Iron Works, Erie, Pa.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
J. H. McEwen Mfg Co., Dey St., N. Y.
Maryland Steel Co., Sparrows Point, Md.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robert Wetherill & Co., Chester, Pa.

Evaporators.

Wheeler Condenser & Eng. Co ,39 Cortlandt St., N.Y

Excavators.

Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, New York.
Vulcan Iron Works, Toledo, Ohio.

Expansion Tanks.

Hepe, Koven & Co., 18 Spruce St., N. Y.

Extensible Sewer Brace.

Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Goubert Mfg. Co., 14 Church St., N. Y.
Fraser & Chalmers, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng Co., 39 Cortlandt St., N.Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Files.

Nicholson File Co., Providence, R. I.

Filters.

Continental Filter Co., 44 Wall St., N. Y.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.

Fire Department Equipment.

American Ball Nozzle Co., 837 Broadway, N. Y.,

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Foot and Hand Presses.

Toledo Machine & Tool Co., Toledo, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.

Forgings.

Middletown Car Works, Middletown, Pa.
Toledo Machine & Tool Co , Toledo, Ohio.

Furnace Builders.

Fraser & Chalmers, Chicago, Ill,
Julian Kennedy, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.

Furniture, Office.

The Globe Co , Cincinnati, Ohio.

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Furniture and Chair Machinery.

J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure, Steam, Water, etc.

Bristol Co., Waterbury, Conn.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.
Hohmann & Maurer Mfg. Co., Brooklyn, N. Y.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Continental Iron Works, Brooklyn, N. Y.
Crane Company, Chicago, Ill.
Jenkins Brothers, 71 John St., N. Y.
The Fairbanks Co., New York.

Gear Cutters.

Brown & Sharpe Mfg. Co., Providence, R. I.
Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dayton Globe Iron Works Co., Dayton, Ohio.
New Process Rawhide Co., Syracuse, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hand Cars.

Sheffield Car Co., Three Rivers, Mich.

Hangers.

SEE PULLEYS, ETC.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

American Boiler Co., Chicago, Ill.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
S. Wilks Mfg. Co., Chicago, Ill.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Hod Hoisting Machinery.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Fire Bricks.

Empire Fire-Proofing Co., Pittsburg, Pa.
Henry Maurer & Son, 420 E. 23d St., New York.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.

Hydraulic Machinery.

Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Queen & Co., Inc., Philadelphia, Pa.

Injectors.

American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

W. R. Brixey, 203 Broadway, N. Y.
Eastern Electric Cable Co., Boston, Mass.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Insulating Paper.

Standard Paint Co., 2 Liberty St., N. Y.

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Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Kyanizing.

Otis Allen & Son, Lowell, Mass.

Lamps, Electric.

Fort Wayne Electric Corporation, Fort Wayne, Ind.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.

Bradford Mill Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Lead Corroders.

Harrison Bros. & Co., Philadelphia, Pa.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
Pittsburg Locomotive Works Pittsburg, Pa.
H. K Porter & Co., Pittsburg, Pa.
Thomas Carlin's Sons, Allegheny, Pa,

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburg, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Sherwood Mfg. Co., Buffalo, N. Y.

Lumber and Shingles.

Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

Armstrong Bros. Tool Co., Chicago, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Charles H. Besly & Co,, Chicago Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Long & Allstatter Co., Hamilton, Ohio
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y
Robert Poole & Son Co., Baltimore, Md.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
The Wilkinson Co , Chicago, Ill.
The Wright Co., Lowell, Mass.

Marine Machinery.

W. A. Crook & Bros Co., Newark, N. J.
Marine Iron Works, Chicago, Ill.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Inc. Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Merchant Steel.

Wm. Jessop & Sons, Limited. 91 John St., N. Y.

Metal Punching and Shearing.

Harrington & King Perforating Co,, Chicago, Ill.

Metallurgical Supplies.

Colorado Iron Works, Denver, Colo.

Meters, Electric.

Fort Wayne Electric Corporation, Fort Wayne, Ind.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.

Milling Machines.

Brown & Sharpe Mfg. Co., Providence, R. I.
Ingersoll Milling Machine Co., Rockford, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.

Mine Cars.

Colorado Iron Works, Denver, Colo.

Mining Machinery

Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
Colorado Iron Works, Denver, Colo.
W. A. Crook & Bros. Co., Newark, N. J.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N.
Jeffery Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Mining Screens.

Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.

H. B. Coho & Co., 203 Broadway New York.
Eddy Electric Manufacturing Co., Windsor, Conn,
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Gates Electric Mfg. Co , Chicago, Ill.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Nickel.
Canadian Copper Co., Cleveland, O.

Nut Locks.
Eureka Nut Lock Co., Pittsburg, Pa.

Oil Cups
Sherwood Mfg. Co., Buffalo, N. Y.

Ore Roasting Machinery.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.

Ornamental Iron Work.
Winslow Bros. Co., Chicago, Ill.

Packing
The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Jenkins Brothers, 71 John St., N. Y.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Sherwood Mfg. Co., Buffalo, N. Y.

Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Joseph Dixon Crucible Co., Jersey City, N. J.
Harrison Bros. & Co., Philadelphia, Pa.
Standard Paint Co., 2 Liberty St., N. Y.

Paper Mill Machinery.
Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Penstocks.
Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds).
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.
Rochester Optical Co., Rochester, N. Y.

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Addyston Pipe & Steel Co., Cincinnati, Ohio.
Jeanesville Iron Works, Jeanesville, Pa.
Charles Millar & Son, Utica, New York.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.
National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.
Michigan Pipe Co., Bay City, Mich.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Pipe Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., St. Louis, Mo.

Pipe, Sewer.
Charles Millar & Son, Utica, New York.
Union Sewer Pipe Co., Akron, Ohio.

Pipe, Wrought Iron, Line and Drive.
Crane Company, Chicago, Ill.
Morris, Tasker & Co., Philadelphia, Pa.

Planing Mill Machinery.
J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.

Plating Materials.
Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Portable Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Power Punches and Shears.
Long & Allstatter Co., Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Preservation of Lumber.
Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic.
Maryland Steel Co., Sparrows Point, Md
Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Pressure Regulators.
The Fairbanks Co., New York.
Van Auken Steam Specialty Co., Chicago, Ill.

Prospecting Drills.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulley Lathes.
Fitchburg Machine Works, Fitchburg, Mass.

Pulleys, Shafting and Hangers.
Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

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Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Fraser & Chalmers, Chicago, Ill.

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Edw. P. Allis Co., Milwaukee, Wis.
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Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
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Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeanesville Iron Works, Jeanesville, Pa.
John H. McGowan Co., Cincinnati, Ohio.
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Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
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M. C. Bullock Mfg. Co., Chicago, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
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Rand Drill Co., 23 Park Place, N. Y.
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Harrington & King Perforating Co., Chicago, Ill.

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Crane Company, Chicago, Ill.
H. B. Smith Co., 137 Center St., N. Y.

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Maryland Steel Co., Sparrows Point, Md.
Vulcan Iron Works, Toledo, Ohio.

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Westinghouse Air Brake Co., Pittsburg, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

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The Okonite Co., Limited, 13 Park Row, N. Y.

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Niles Tool Works, Hamilton, Ohio.
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C. B. Rogers & Co., Norwich, Conn.
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Stow Manufacturing Co., Binghamton, N. Y.
The Wright Co., Lowell, Mass.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

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Iron City Tool Works, Ltd., Pittsburg, Pa.
Middletown Car Works, Middletown, Pa.
New York Air Brake Co., 66 Broadway, N. Y.
H. K. Porter & Co., Pittsburg, Pa.
Sheffield Car Co., Three Rivers, Mich.
Westinghouse Air Brake Co., Pittsburg, Pa.

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Sheffield Car Co., Three Rivers, Mich.

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Harrison Bros. & Co., Philadelphia, Pa.

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Ross Valve Co., Troy, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

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Addyston Pipe & Steel Co., Cincinnati, Ohio.
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O. S. Kelly Co., Springfield, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

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Addyston Pipe & Steel Co., Cincinnati Ohio.
Harrisburgh F'd'y & Machine W'ks, Harrisburg, Pa.
O. S. Kelly Co., Springfield, Ohio.

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Edw. P. Allis Co., Milwaukee, Wis.
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Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

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Walker Manufacturing Co., Cleveland, Ohio.

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Gummey, McFarland & Co., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Riter & Conley, Pittsburg, Pa.
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Translucent Fabric Co., Boston, Mass.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
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Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

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Fraser & Chalmers, Chicago, Ill.
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Link-Belt Engineering Co., Nicetown, Phila. Pa.,

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Jenkins Brothers, 71 John St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Spinney, Virtue & Co., Lynn, Mass.

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Edw. P. Allis Co., Milwaukee, Wis.

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Cheltenham Academy, Ogontz, Pa.

Screens, Mining.

Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Screen Plates, Punched.

Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.

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Bignall & Keeler Mfg. Co., St. Louis, Mo.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Niles Tool Works, Hamilton, Ohio.

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New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

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F. D. Cummer & Son Co., Cleveland, Ohio.
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Separators, Steam.

Goubert Mfg. Co., 14 Church St., N. Y.

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Union Sewer Pipe Co., Akron, Ohio,

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Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

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Canton Steel Roofing Co., Canton, Ohio.
Translucent Fabric Co., Boston, Mass.

Slate.

James L. Foote, Slatington, Pa.

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Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

Spark Guards, Perforated.

Harrington & King Perforating Co., Chicago,

Standpipes.

Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

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Crane Company, Chicago, Ill.

Steam Regulating Appliances.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
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Penberthy Injector Co., Detroit, Mich.
Jenkins Brothers, 71 John St., N. Y.
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Reliance Gauge Co., Cleveland, Ohio.
Ross Valve Co., Troy, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

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Atlantic Works, East Boston, Mass.

Steam Shovels.

Thomas Carlin's Sons, Allegheny, Pa.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

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Buffalo Forge Co., Buffalo, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Van Auken Steam Specialty Co., Chicago, Ill.

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Wm. Jessop & Sons, Ltd., 91 John St., N. Y.

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Continental Iron Works, Brooklyn, N. Y.
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Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

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Theo. Alteneder & Sons, Philadelphia, Pa.
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Keuffel & Esser Co., 127 Fulton St., N.
Queen & Co., Inc , Philadelphia, Pa.

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Fraser & Chalmers, Chicago, Ill.
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Pittsburg Locomotive Works, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
S. Wilks Mfg. Co., Chicago, Ill.

Tanks, Wood.

Williams Mfg. Co., Kalamazoo, Mich.

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John A. Roebling's Sons Co., Trenton, N. J.
The Okonite Co., Ltd., 13 Park Row, N. Y.

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United Electric Telephone Co., New York.

Testing Machinery.

Wm. Sellers & Co., Philadelphia, Pa.

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Queen & Co., Inc., Philadelphia, Pa.

Tin.

Gummey, McFarland & Co., Philadelphia, Pa.
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Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
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Trenton Iron Co., Trenton, N. J.
C. W. Hunt Co., 45 Broadway N. Y.

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Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill Co., Chester, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.

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Sherwood Mfg. Co., Buffalo, N. Y.

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Cleveland Twist Drill Co., Cleveland, Ohio.
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Deane Steam Pump Co., Holyoke, Mass.

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Sherwood Mfg. Co., Buffalo, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

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Trenton Iron Co., Trenton, N. J.

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Stow Flexible Shaft Co., Ltd., Philadelphia, Pa
The Wilkinson Co., Chicago, Ill.

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Marion Steam Shovel Co., Marion, Ohio
Middletown Car Works, Middletown, Pa.

Yachts, Steam.

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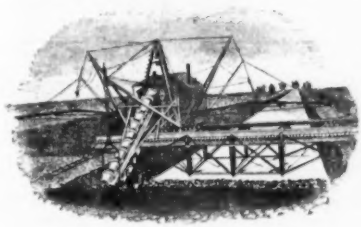

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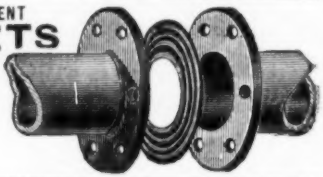

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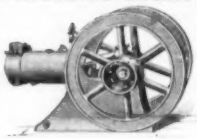

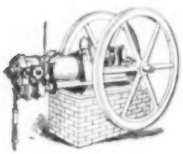

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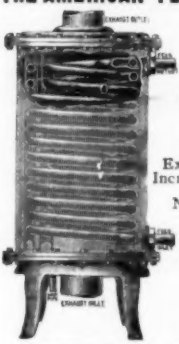

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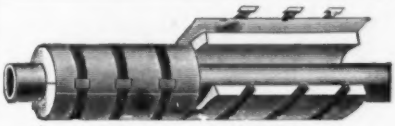

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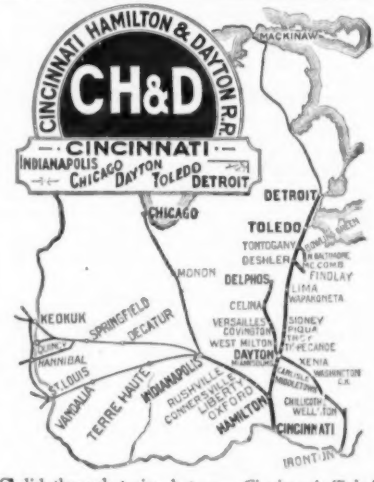

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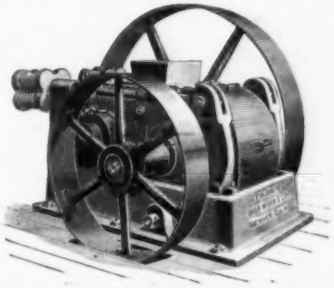

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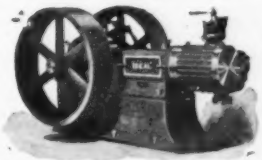

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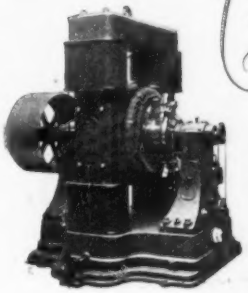

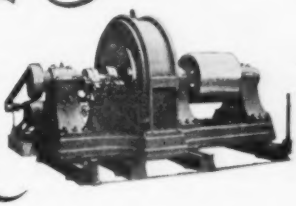

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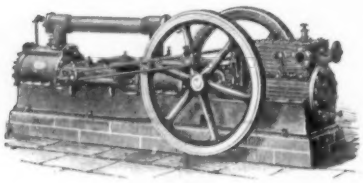

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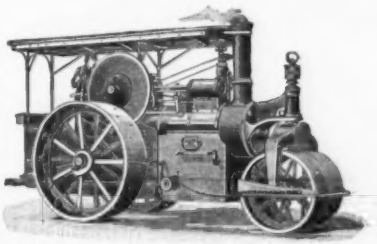

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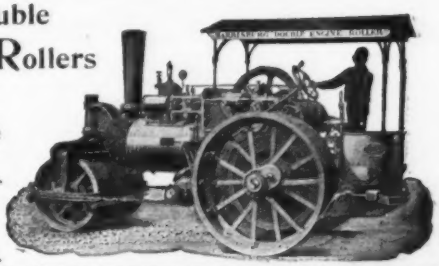

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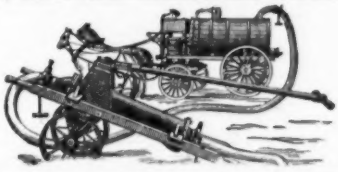

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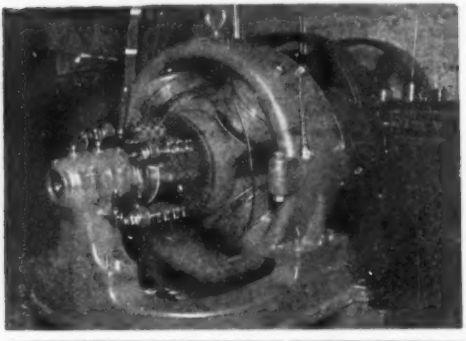

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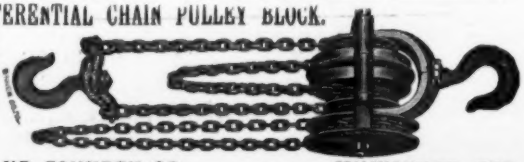

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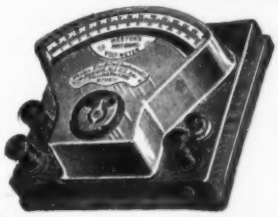

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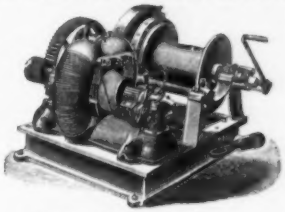

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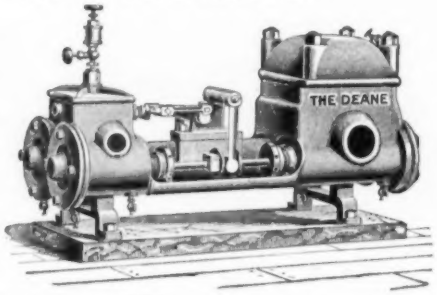

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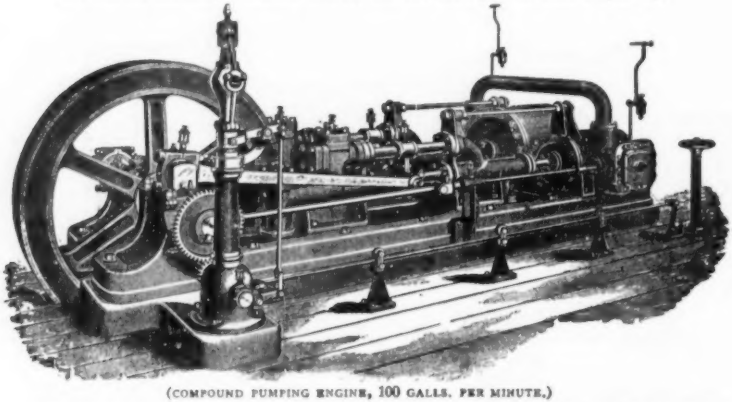

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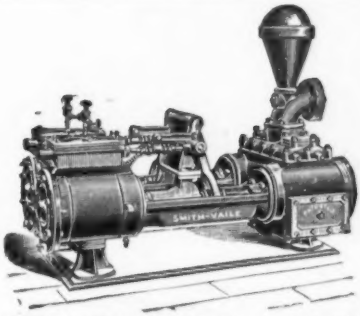

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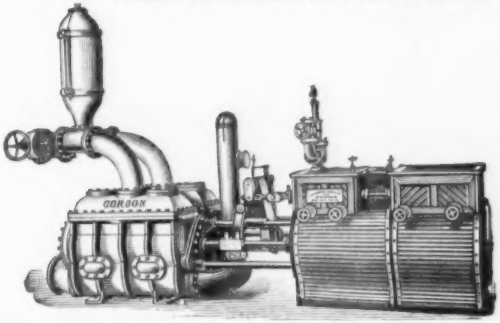

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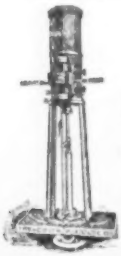

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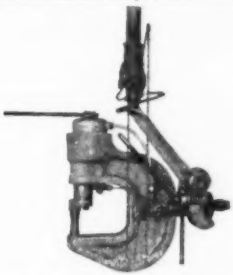

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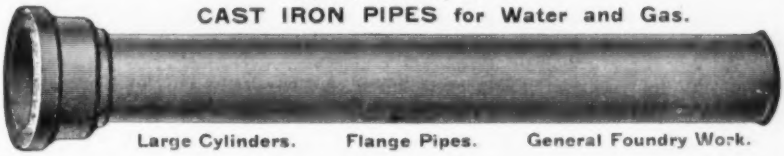

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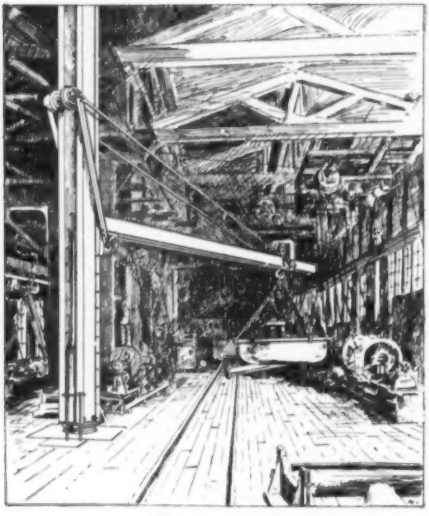

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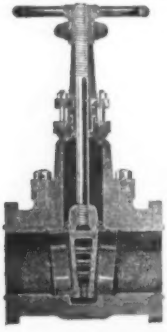

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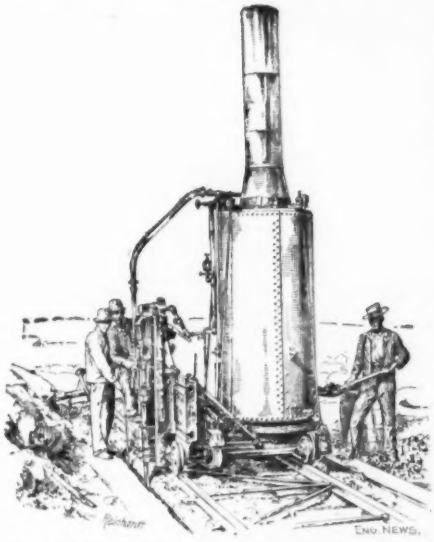

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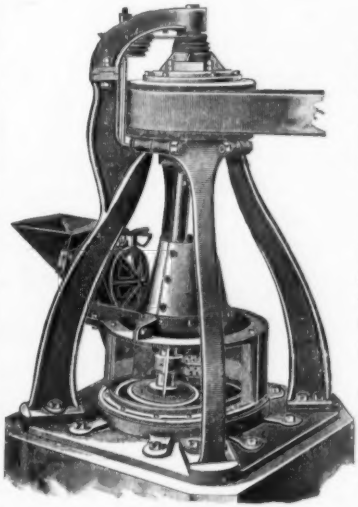

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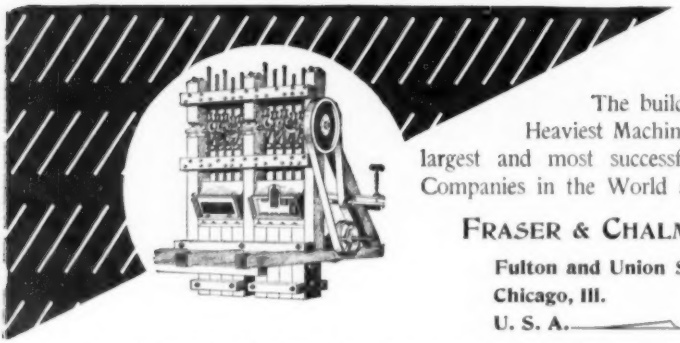

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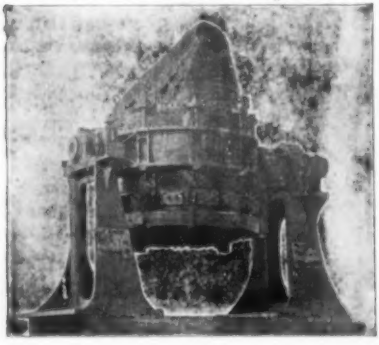

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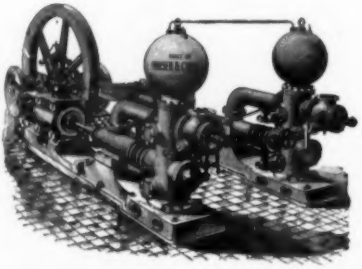

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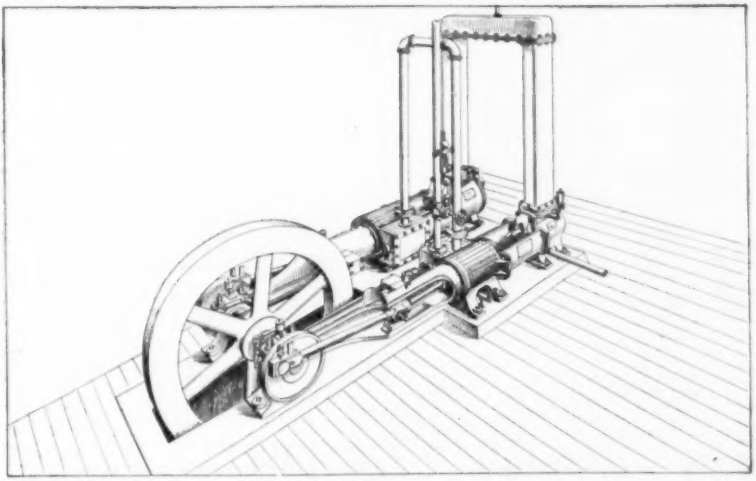

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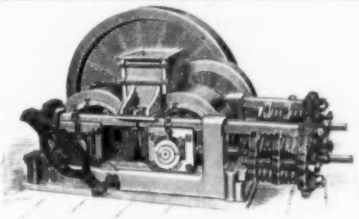

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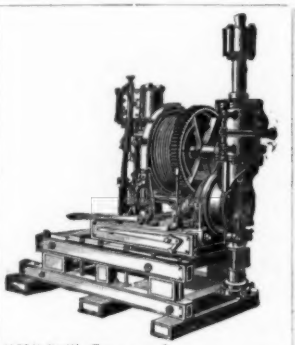

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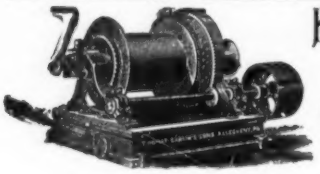

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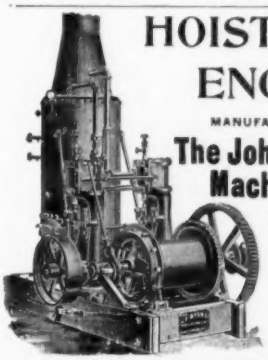

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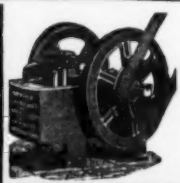
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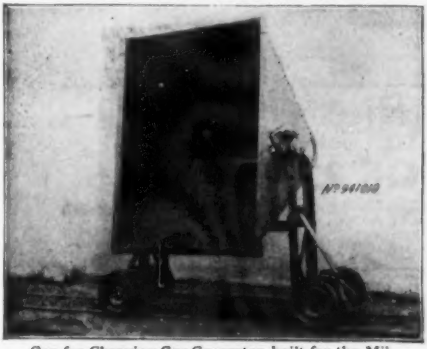

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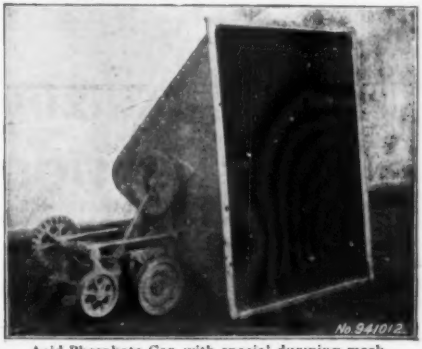

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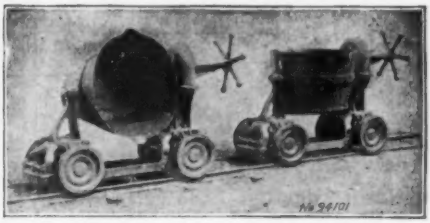

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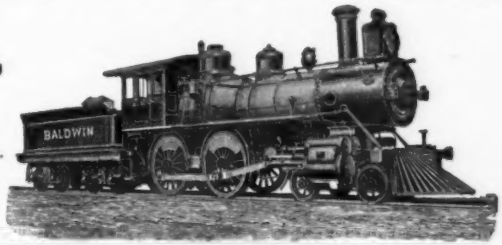

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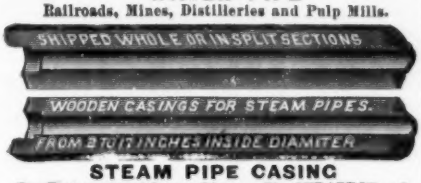

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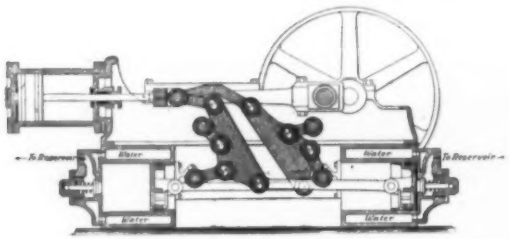

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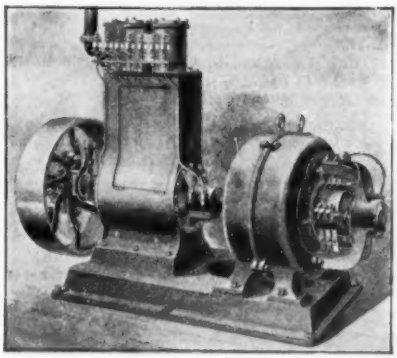

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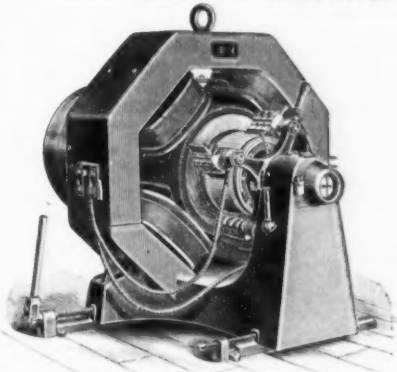

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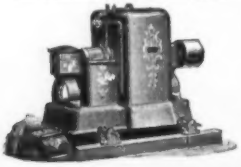

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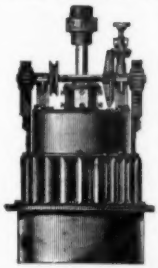

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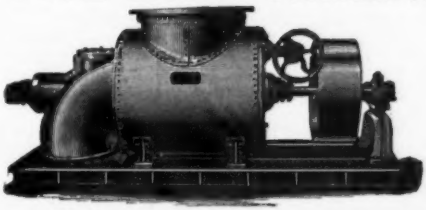

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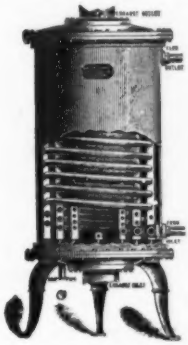

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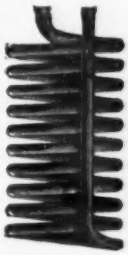

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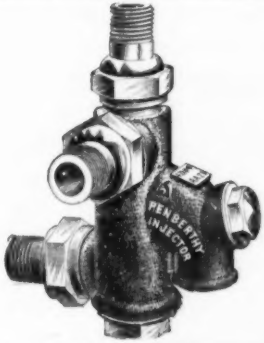

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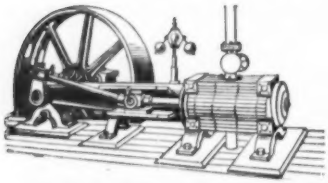

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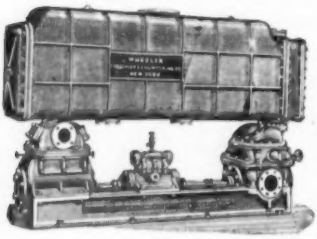

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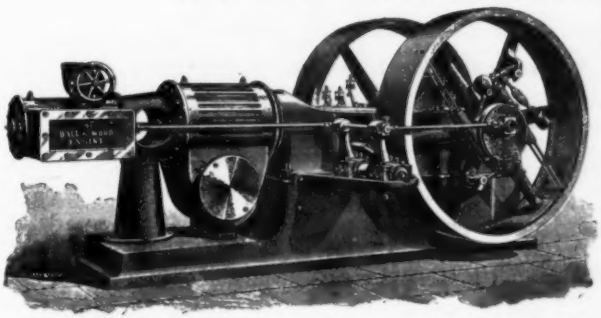

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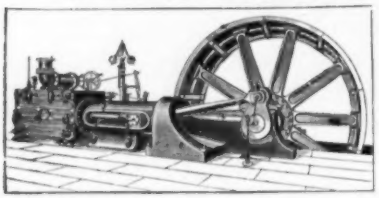

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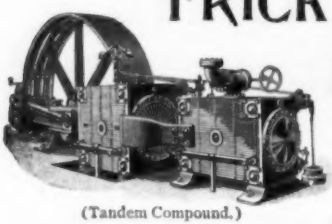

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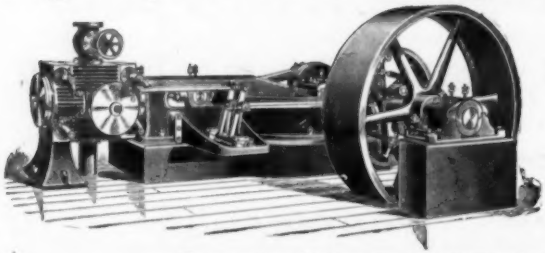

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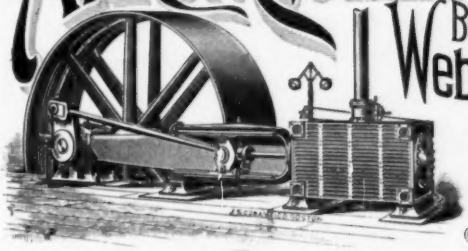

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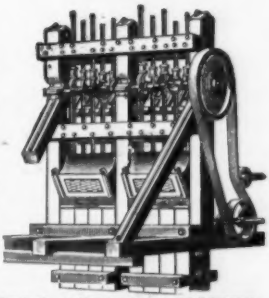

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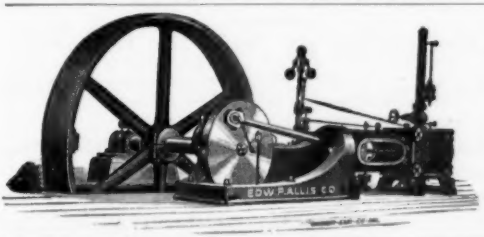

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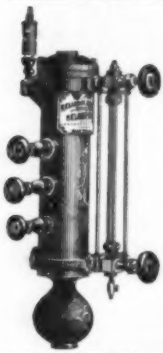

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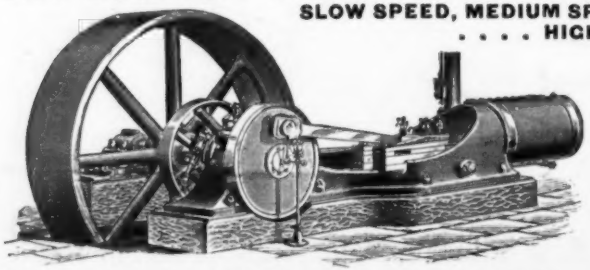

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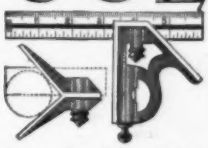

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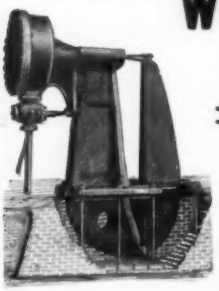

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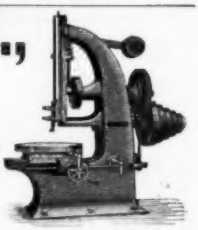

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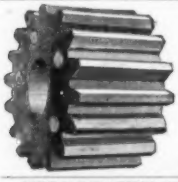

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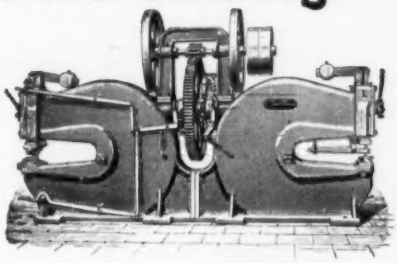

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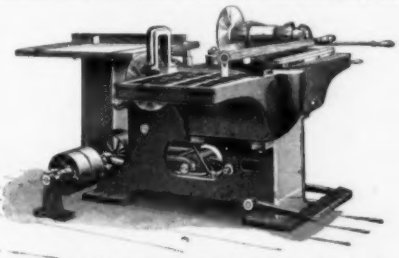

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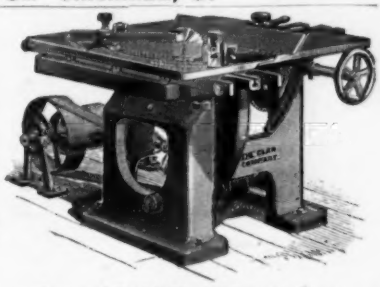

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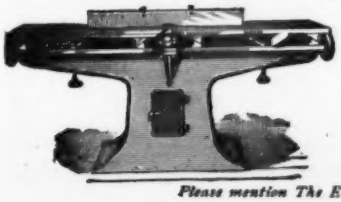

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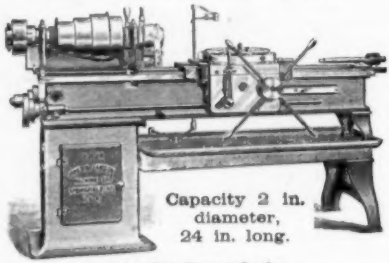

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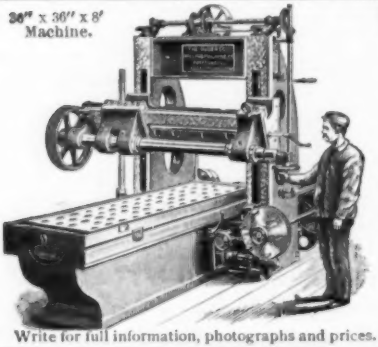

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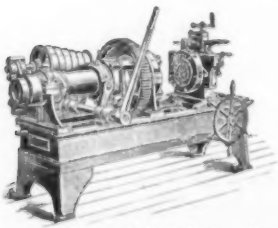

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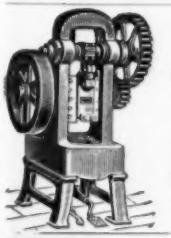

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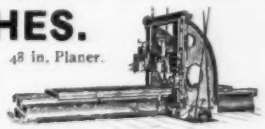

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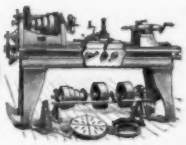

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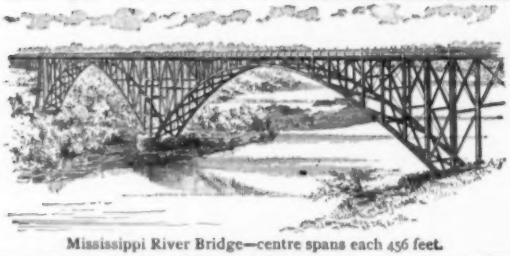

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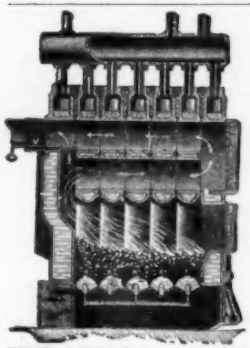

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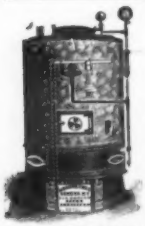

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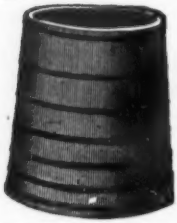

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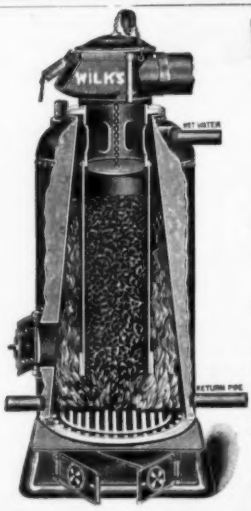

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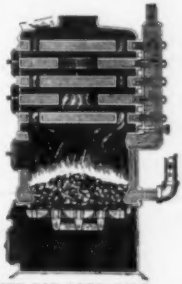

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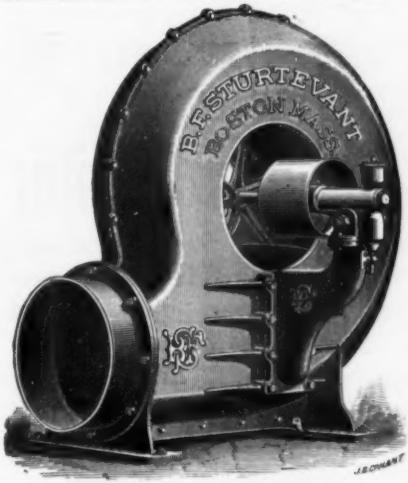

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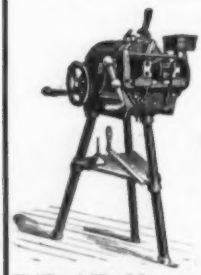
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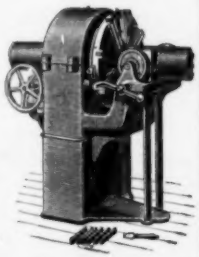
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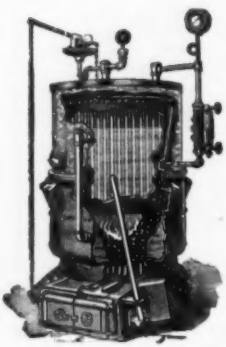

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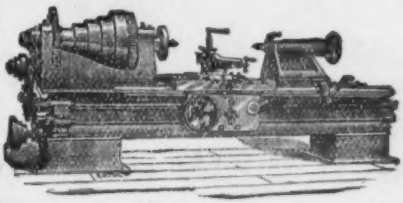

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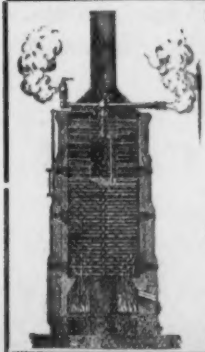

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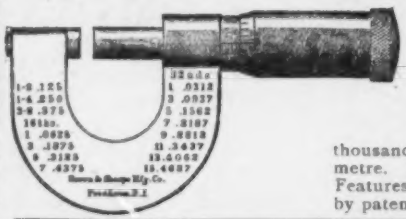

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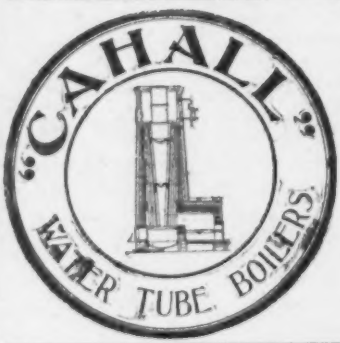

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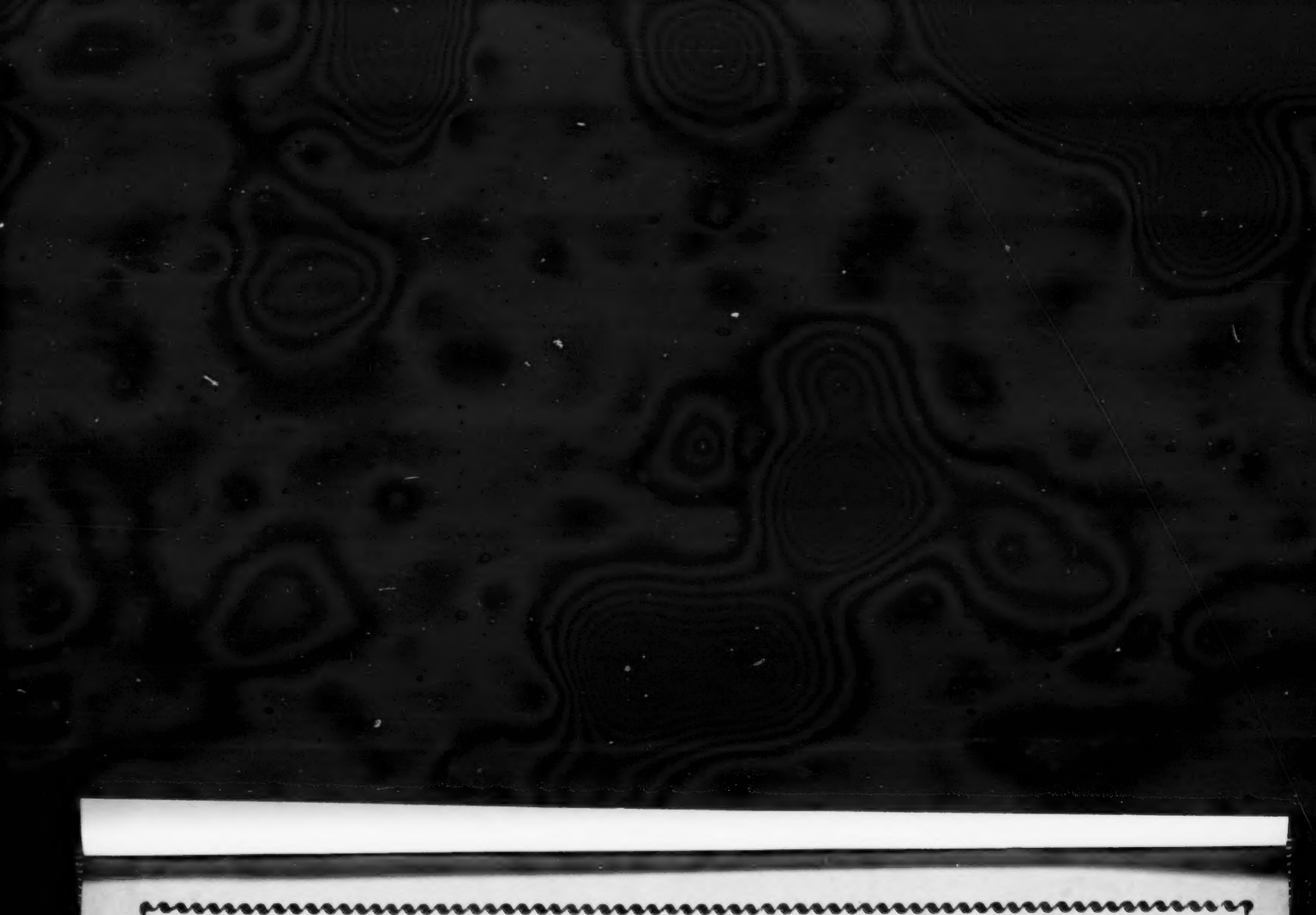

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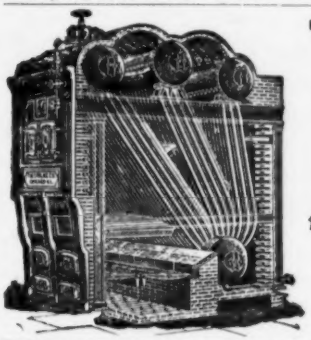

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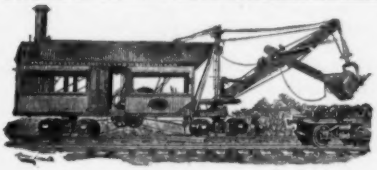

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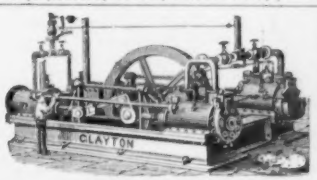

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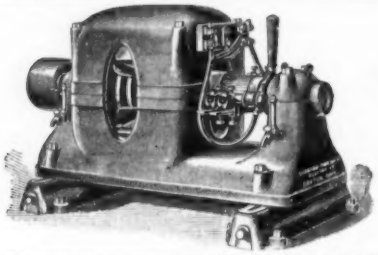

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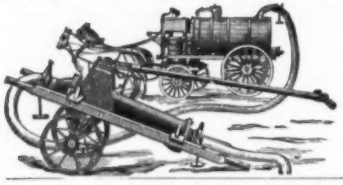

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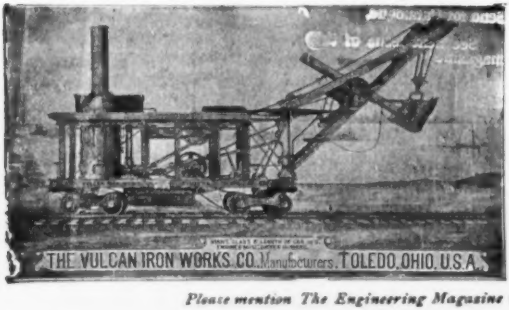

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AUTHORS AND PAPERS THIS MONTH.

JOHN R. DUNLAP (*The Money Question and Constructive Enterprise*)=Editor of The Engineering Magazine.

J. SELWYN TAIT (*The Scotch System of Branch Banks*)=Educated in Scotland and learned banking in the British Linen Company Bank, one of the oldest and best banking institutions of Scotland; after went to London where he joined a large joint stock bank; in 1869 appointed a branch manager of that bank (London & South Western Bank) and the number of branches under his charge was finally increased to six; during his service as manager established several branches among new communities and was therefore able to gain a practical knowledge of the stimulus which branch banks are to the localities in which they are established; for many years a Fellow of the Royal Literary Society of London; since residing in the United States has written extensively for the press on financial subjects, over his own signature, his contributions to the New York *Evening Post* being especially well known. Mr. Tait is the author of a *brochure*—now out of print—entitled "National Banks and Government Circulation," which attracted wide attention in 1888 and was very favorably reviewed by banking journals and the press generally. In that *brochure* he advocated the establishment of branch banks. Of an article written by Mr. Tait entitled "Iniquity of Free Coinage" President Cleveland has said that it was the clearest exposition of the situation that he had seen up to that time, 1891; is now at the head of the firm of Selwyn Tait and Sons, publishers, New York city.

MICHAEL IDVORSKY PUPIN (*Professor Röntgen's Discovery of a New Radiance*)=Born in the military frontier of Austria; graduated at Columbia College, New York, in 1883; studied under Helmholtz and obtained his doctor degree at the University of Berlin in 1889; is now adjunct professor in mechanics at Columbia College; has devoted much time to electrical investigations; is member of the New York Academy of Sciences and vice president of the American Institute of Electrical Engineers.

FOSTER CROWELL (*The Railroad Facilities of Suburban New York*)=A well known railroad expert; born Oct. 13, 1848, in West Chester, Pa.; his boyhood was passed in Orange, N. J; graduated as a Civil Engineer at the Polytechnic College of Pennsylvania in 1867; has ever since been actively engaged in the practice of his profession, chiefly in railroad and hydraulic matters; he took a prominent part in the early explorations and surveys for the Nicaragua Canal, in 1872 and 73, and has been identified with many important engineering works in this country and abroad; was for a number of years engineer of construction for the Pennsylvania Railroad, and is an acknowledged expert in railroad location, construction and economics; for some years past he has been established as a consulting engineer at No. 18 Broadway, New York; is a member of the American Society of Civil Engineers, the Institution of Civil Engineers of Great Britain, the Geographical Society, the Engineers' Club, and other organizations; has written a number of technical papers which have appeared in the publications of scientific bodies, and at times is a contributor to the technical press and the popular magazines.

LOUIS L. TRIBUS (*Standpipes for Fire Protection and Street Flushing*)=Born Northampton, Mass.; graduated at University of the City of New York; associate member Am. Soc. C. E.; was for three years instructor of civil engineering in the University of the City of New York; for ten years engaged in hydraulic and sanitary work; has traveled extensively in this

country and abroad investigating these special fields; has been connected with the design and construction of many municipal works in New York, New Jersey, Pennsylvania, Ohio, Virginia, Alabama and Florida. Since 1893 Mr. Tribus has engaged in private consulting practice—water works and sewerage systems particularly—and has contributed occasionally to the technical and general press on constructive and sanitary matters.

E. T. ADAMS (*Artistic Engine-Room Interiors*)—Received a varied technical training, working his way up from the workman's bench; early training in public schools at Hyde Park, Ill.; after a number of years work, chiefly in mechanical lines, received a university education at Stanford and at Cornell; his experience as stationary engineer entitles him to speak with authority on the status of this occupation; was instructor in charge of the department of drawing in city schools of Stockton, Cal.; instructor in mechanical drawing and descriptive geometry at Stanford University; graduate Cornell University, M. E., 1894; employed as designer by a prominent firm of engine builders; and at present instructor in department of machine design, Cornell University. Has contributed more or less to technical and other papers for several years past.

AUGUSTUS NOLL (*Lighting Residences by Electricity*)—Born in New York city in 1860; a graduate of the public schools of the city; subsequently studied mathematics and electrical and mechanical engineering; in 1880 became connected with the old Edison Electric Light Co. in the installation department, and with the meter department of the pioneer first district station, and was also engaged on experimental work in the Edison Machine Works; he subsequently installed Edison lighting plants in various places; in 1885 commenced business for himself as a contractor, and did much difficult work in renovating old plants; employed on the important Edison installation at the Louisville exposition—the first three-wire plant ever installed; has published a work entitled "How to Wire Buildings"; is now the head of the contracting firm Noll & MacLean. Mr. Noll is an acceptable contributor to electrical publications, and a member of the American Institute of Electrical Engineers.

R. W. GIBSON (*The Architecture of Modern Bank Buildings*)—Born in Essex, England, in 1854; studied architecture in the offices of Henry Jarvis and Charles Henman, in London, and in the Schools of the Architectural Association; became in 1875 a student in the Royal Academy of Arts, during the period when Street, Pearson, and Norman Shaw were visiting professors; won medals in 1876 and 1878 and traveling studentship in 1879; came to America in 1881 and engaged in practice in architecture in Albany, N. Y., where he designed the cathedral of that city; removed to New York in 1888; in his profession has specialized the study of ecclesiastical and bank-office buildings, and has written occasional technical papers and essays.

J. PARKE CHANNING (*Prospecting with the Diamond Drill*)—Born in New York City 1863; graduated at Columbia School of Mines in 1883; soon after went to Houghton, Michigan, with S. E. Cleaves & Son, manufacturers of mining machinery; afterward with the Tamarack, and Osceola mines as assistant mining engineer; was appointed deputy commissioner of mineral statistics, and wrote that part of the State report for 1884 covering the copper mines; spent a year in Honduras for Michigan capitalists, establishing steamboat navigation on the Ulua River and examining places and mineral lands; returned to Michigan in practice of general engineering, and in 1887 was appointed Inspector of Mines for Gogebic Co., holding that place till 1890; was superintendent of the East New York Iron Mine, and later in charge of the development company in Michigan of the Chicago, Milwaukee and St. Paul Ry.; resigned to accept a position with the Calumet and Hecla Mining Co. as assistant manager; since 1894 has been located at 34 Park place, New York City, as consulting engineer. It was at his suggestion, in 1885, that the Michigan Mining School was established. His proposal led to the founding of the Lake Superior Mining Institute, of which he was president in 1895. He has been an occasional contributor to the technical press.

H. VAN F. FURMAN (*Practical Assaying at Mines and Works*)—Born May 17, 1860 in New York City; graduated from the School of Mines of Columbia College June 1881, taking the degree of Engineer of Mines; since graduation has been engaged principally in Colorado, Utah and New Mexico as assayer, chemist and metallurgist; has been connected at different times with The Germania Lead Works of Salt Lake City, The Globe Smelting and Refining Works of Denver, Colo., The Rio Grande Smelting Works of Socorro, N. M., and other metallurgical and mining establishments; is at present Chief Assayer at the United States Mint, Denver, Colo. Has contributed numerous papers on chemical and metallurgical subjects to various technical journals and scientific societies, and is the author of "A Manual of Practical Assaying."

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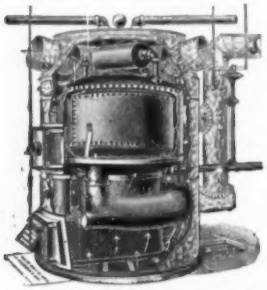

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Fraser & Chalmers, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
New York Air Brake Co., 66 Broadway, N. Y.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
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Wheeling Corrugating Co., Wheeling, W. Va.

Ball Nozzles.

American Ball Nozzle Co., 837 Broadway, N. Y.

Ballast Unloaders.

Marion Steam Shovel Co., Marion, Ohio.

Baths.

Standard Manufacturing Co., Pittsburg, Pa.

Belt Dressing.

Jos. Dixon Crucible Co., Jersey City, N. J.

Belting.

Boston Belting Co., Boston, Mass.
Home Rubber Co., Trenton, N. J.
Main Belting Co., Philadelphia, Pa.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
N. J. Car Spring & Rubber Co., Jersey City, N. J.
New York Belting & Packing Co., Ltd., New York.

Belt Lacing.

Bristol Co., Waterbury, Conn.

Blacksmiths' Tools.

Buffalo Forge Co., Buffalo, N. Y.

Blast Furnaces.

Maryland Steel Co., Sparrows Point, Md.

Blowers.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
Fraser & Chalmers, Chicago, Ill.
B. F. Sturtevant Co., Boston, Mass.

Boilers.

American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass
Edw. P. Allis Co., Milwaukee, Wis.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Colorado Iron Works, Denver, Colo.
Buckeye Engine Co., Salem, Ohio.
H. E. Collins & Co., Pittsburg, Pa.
Continental Iron Works, Brooklyn, N. Y.
Earle C. Bacon, 26 Cortlandt St. N. Y.
Erie City Iron Works, Erie, Pa.
Fraser & Chalmers, Chicago, Ill.
The Hazelton Boiler Co., 716 E. 13th St., New York.
Heine Safety Boiler Co., St. Louis, Mo.
Maryland Steel Co., Sparrows Point, Md.
Mundy, J. S. Newark, N. J.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Stirling Co., Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.

Boiler Fronts and Fittings.

Reliance Gauge Co., Cleveland, Ohio.
Riter & Conley, Pittsburg, Pa.
Vulcan Iron Works, Toledo, Ohio.

Boiler Inspectors.

Hartford S. B. I. & Ins. Co., Hartford, Conn.

Bolt Cutters.

Acme Machinery Co., Cleveland, Ohio.

Bolt and Rivet Headers.

Acme Machinery Co., Cleveland, Ohio.

Boring Machines.

Fitchburg Machine Works, Fitchburg, Mass.
Lodge & Shipley Machine Tool Co., Cincinnati, O.

Bricks.

Empire Fire-Proofing Co., Pittsburg, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
Pittsburg Terra Cotta Lumber Co, Pittsburg, Pa.

Bridge Builders.

Berlin Iron Bridge Co., East Berlin, Conn.
The Continental Iron Works, Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.

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Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Brick and Tile Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co. Columbus, Ohio.

Building Materials.

Berlin Iron Bridge Co., East Berlin, Conn.
T. H. Brooks & Co., Cleveland, Ohio.
Canton Steel Roofing Co., Canton, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Empire Fire-Proofing Co., Pittsburg, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
Harrison Bros & Co., Philadelphia, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
James L. Foote, Slatington, Pa.
Joseph Dixon Crucible Co., Jersey City, N. J.
Maryland Steel Co., Sparrows Point, Md.
A. Northrop & Co., Pittsburg, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Pittsburg Terra Cotta Lumber Co, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Standard Paint Co, 2 Liberty St., N. Y.
Translucent Fabric Co., Boston, Mass.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co., Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Cable Railways.

Robert Poole & Son Co., Baltimore, Md.

Cable Railway Driving Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Cables, Electric and Submarine.

Eastern Electric Cable Co., Boston, Mass.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Cableways.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calcining and Drying Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.

Calipers and Dividers.

L. S. Starrett, Athol, Mass.

Cameras.

Eastman Kodak Co., Rochester, N. Y.
Rochester Optical Co., Rochester, N. Y.

Cams and Tappets.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Carpenters' Tools.

L. S. Starrett, Athol, Mass.

Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
C. B. Rogers & Co., Norwich, Co n.
J. A. Fay & Egan Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co, Providence, R. I.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
McNeal Pipe and Foundry Co., Burlington, N. J.
Middletown Car Works, Middletown, Pa
Ohio Pipe Co., Columbus, Ohio.
Riter & Conley, Pittsburg, Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Philadelphia, Pa.

Chemical Works Machinery.

Fraser & Chalmers, Chicago, Ill.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Clay Working Machinery.

W. J. Clark & Co., Salem, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Closets.

Standard Manufacturing Co., Pittsburg, Pa.

Clutches, Friction.

J. S. Mundy, Newark, N. J.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Coal Mining Machinery.

Buffalo Forge Co., Buffalo, N. Y.
W. J. Clark & Co., Salem, Ohio.
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
C. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Concentrators and Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Sturtevant Mill Co., Boston Mass.

Condensers, Jet.

Deane Steam Pump Co., Holyoke, Mass.

Condensers, Surface.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y

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Consulting Engineers.

Alton D. Adams, Worcester, Mass.
D. Ashworth, Pittsburg, Pa.
Wm. H. Bryan, St. Louis, Mo.
C. M. Conradson, Madison, Wis.
Henry C. Eddy, Chicago, Ill.
Dr. Willis E. Everette, Tacoma, Wash.
M. Fargusson, Southport, N. C.
C. T. Gooding, Tucson, Ariz.
E. B. Hussey, Seattle, Wash.
E. P. Jennings, Ironwood, Mich.
Julian Kennedy, Pittsburg, Pa.
A. L. McRae, Austin, Texas.
Frank Nicholson, Phoenix, Ariz.
Pittsburg Testing Lab'y. Ltd., Pittsburg, Pa.
Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
Vandenbergh Lab'y of Chem. Ind., Buffalo, N. Y.
Wm. O. Webber, Boston, Mass.

Contractors' Dump Cars, etc.

Gates Iron Works, Chicago, Ill.
Middletown Car Works, Middletown, Pa.
Sheffield Car Co., Three Rivers, Mich.

Contractors' Supplies.

Thomas Carlin's Sons, Allegheny, Pa.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.

Conveying Machinery.

Brown Hoisting & Conveying Mch. Co., Clevel'nd, O.
W J. Clark & Co , Salem, Ohio.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link-Belt Engineering Co., Phila., Pa.

Copper.

Canadian Copper Co., Cleveland, O.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Wheeling Corrugating Co., Wheeling, W. Va.

Cranes.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Berlin Iron Bridge Co., East Berlin, Conn.
Brown Hoisting & Conveying Mch Co., Clevel'nd, O.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Crushers, Ore, Phosphate, Rock.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Earle C. Bacon, 26 Cortlandt St., N. Y.
F. M. Davis Iron Works, Denver, Col.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Sturtevant Mill Co., Boston, Mass.

Diamond Drills.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 23 Park Place, N. Y.

Dies and Die Forgings.

Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Dredging Machines.

W. J. Clark & Co., Salem, Ohio.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point, Md.
New York Dredging Co., 61 Park Row, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

Buffalo Forge Co., Buffalo, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Presses.

Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co , Sparrows Point, Md.

Dynamos.

H. B. Coho & Co., 203 Broadway, New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Gates Electric Mfg. Co , Chicago, Ill.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.

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Jeffrey Mfg. Co., Columbus, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Machinery and Supplies.

Bristol Co., Waterbury, Conn.
H. B. Coho & Co., 203 Broadway, New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Gates Electric Mfg. Co., Chicago, Ill.
Hanson & Van Winkle Co., Newark, N. J.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Morris, Tasker & Co., Philadelphia, Pa.
Queen & Co., Inc., Philadelphia, Pa.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
H K. Porter & Co., Pittsburg, Pa.

Electroplating and Electrotyping Machines.

Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Emery Wheels.

Manhattan Rubber Mfg. Co., 61 Cortlandt St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Emery Wheel Machinery.

Bignall & Keeler Mfg. Co., St. Louis, Mo.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Queen & Co., Inc., Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engine Governors.

J. H. McEwen Mfg. Co., Dey St., N. Y.

Engines, Gas, Gasoline, and Petroleum.

J. J. Norman Co., Chicago, Ill.
Otto Gas Engine Works, Philadelphia, Pa.
Pierce Engine Co., Racine, Wis.
Springfield Gas Engine Co., Springfield, Ohio.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.

Engines, Stationary.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Colorado Iron Works, Denver, Colo.
Erie City Iron Works, Erie, Pa.
Fishkill Landing Machine Co., Fishkill, N. Y.
Fraser & Chalmers, Chicago, Ill.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Maryland Steel Co., Sparrows Point, Md.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robert Wetherill & Co., Chester, Pa.

Evaporators.

Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Excavators.

Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, New York.
Vulcan Iron Works, Toledo, Ohio.

Expansion Tanks.

Hepe, Koven & Co., 18 Spruce St., N. Y.

Extensible Sewer Brace.

Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Goubert Mfg. Co., 14 Church St., N. Y.
Fraser & Chalmers, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng Co., 39 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Files.

Nicholson File Co., Providence, R. I.

Filters.

Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Fire Department Equipment.

American Ball Nozzle Co., 837 Broadway, N. Y.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Dayton Globe Iron Works Co., Dayton, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.

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Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Foot and Hand Presses.

Toledo Machine & Tool Co., Toledo, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.

Forgings.

Middletown Car Works, Middletown, Pa.
Toledo Machine & Tool Co , Toledo, Ohio.

Furnace Builders.

Fraser & Chalmers, Chicago, Ill,
Julian Kennedy, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.

Furniture, Office.

The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.

J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure, Steam, Water, etc.

Bristol Co., Waterbury, Conn.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Continental Iron Works, Brooklyn, N. Y.
Crane Company, Chicago, Ill.
Jenkins Brothers, 71 John St., N. Y.
The Fairbanks Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.

Gear Cutters.

Brown & Sharpe Mfg. Co., Providence, R. I.
Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dayton Globe Iron Works Co., Dayton, Ohio.
New Process Rawhide Co., Syracuse, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co , Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y,

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hand Cars.

Sheffield Car Co., Three Rivers, Mich.

Hangers.

SEE PULLEYS, ETC.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

American Boiler Co., Chicago, Ill.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
S. Wilks Mfg. Co., Chicago, Ill.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Brown Hoisting & Conveying Mch. Co., Cleveland, O.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Middletown Car Works, Middletown, Pa.
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton. N. J.
Walker Manufacturing Co., Cleveland, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Hod Hoisting Machinery.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Hollow Bricks.

Empire Fire-Proofing Co., Pittsburg, Pa.
Henry Maurer & Son, 420 E. 23d St., New York.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.

Hydraulic Machinery.

Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co , Sparrows Point, Md.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Queen & Co., Inc., Philadelphia, Pa.

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Injectors.

American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

W. R. Brixey, 203 Broadway, N. Y.
Eastern Electric Cable Co., Boston, Mass.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Insulating Paper.

Standard Paint Co., 2 Liberty St., N. Y.

Iron.

Passaic Rolling Mill Co., Paterson, N. J.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Kyanizing.

Otis Allen & Son, Lowell, Mass.

Lamps, Electric.

Fort Wayne Electric Corporation, Fort Wayne, Ind.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.

Bradford Mill Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Lead Corroders.

Harrison Bros. & Co., Philadelphia, Pa.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
Pittsburg Locomotive Works Pittsburg, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Thomas Carlin's Sons, Allegheny, Pa.

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburg, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Sherwood Mfg. Co., Buffalo, N. Y.
Lunkenheimer Co., Cincinnati, Ohio.

Lumber and Shingles.

Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

Acme Machinery Co., Cleveland, Ohio.
Armstrong Bros. Tool Co., Chicago, Ill.
Beaudry & Co., Boston, Mass.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Charles H. Besly & Co., Chicago Ill.
Cleveland Twist Drill Co., Cleveland, Ohio
Fitchburg Machine Works, Fitchburg, Mass.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Long & Allstatter Co., Hamilton, Ohio
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Robert Poole & Son Co., Baltimore, Md.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio
The Wilkinson Co., Chicago, Ill.
Worcester Machine Screw Co., Worcester, Mass.
The Wright Co., Lowell, Mass.

Marine Machinery

W. A. Crook & Bros Co., Newark, N. J.
Marine Iron Works, Chicago, Ill.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Queen & Co., Inc. Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Merchant Steel.

Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Metals.

Wm. Jessop & Sons, Ltd., 91 John St., N. Y.
Passaic Rolling Mill Co., Paterson, N. J.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Metal Punching and Shearing.

Harrington & King Perforating Co., Chicago, Ill.

Metallurgical Supplies.

Colorado Iron Works, Denver, Colo.

Meters, Electric.

Fort Wayne Electric Corporation, Fort Wayne, Ind.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.
Union Wafer Meter Co., Worcester, Mass.

Milling Machines

Brown & Sharpe Mfg. Co., Providence, R. I.
Ingersoll Milling Machine Co., Rockford, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.

Mine Cars.

Colorado Iron Works, Denver, Colo.

Mining Machinery

Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
Colorado Iron Works, Denver, Colo.
W. A. Crook & Bros. Co., Newark, N. J.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N.

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Jeffery Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Mining Screens.

Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.

H. B. Coho & Co., 203 Broadway New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Gates Electric Mfg. Co., Chicago, Ill.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Thresher Electric Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg Pa.

Nickel.

Canadian Copper Co., Cleveland, O.

Nut Locks.

Eureka Nut Lock Co., Pittsburg, Pa.

Oil Cups.

Lunkenheimer Co., Cincinnati, Ohio.
Sherwood Mfg. Co., Buffalo, N. Y.

Ore Roasting Machinery.

Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.

Ornamental Iron Work.

Winslow Bros. Co., Chicago, Ill.

Packing

Boston Belting Co., Boston, Mass.
The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Jenkins Brothers, 71 John St., N. Y.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
N. J. Car Spring & Rubber Co., Jersey, City, N. J.
New York Belting & Packing Co., Ltd., New York.
Sherwood Mfg. Co., Buffalo, N. Y.

Paints.

Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Joseph Dixon Crucible Co., Jersey City, N. J.
Harrison Bros. & Co., Philadelphia, Pa.
Standard Paint Co., 2 Liberty St., N. Y.

Paper Mill Machinery.

Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Penstocks.

Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds)

Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.

Phosphor Bronze.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Photographic Supplies.

Eastman Kodak Co., Rochester, N. Y.
Queen & Co., Inc., Philadelphia, Pa.
Rochester Optical Co., Rochester, N. Y.

Pipe, Cast Iron.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Jeanesville Iron Works, Jeanesville, Pa.
Charles Millar & Son, Utica, New York.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.

National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.

Michigan Pipe Co., Bay City, Mich.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Pipe Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., St. Louis, Mo.

Pipe, Sewer.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Charles Millar & Son, Utica, New York.
Union Sewer Pipe Co., Akron, Ohio.

Pipe, Wrought Iron, Line and Drive.

Crane Company, Chicago, Ill.
Morris, Tasker & Co., Philadelphia, Pa.

Planing Mill Machinery.

J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.

Plating Materials.

Eddy Electric Manufacturing Co., Windsor, Conn.
Hanson & Van Winkle Co., Newark, N. J.

Portable Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Power Hammers.

Beaudry & Co., Boston, Mass.

Power Punches and Shears.

Beaudry & Co., Boston, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Preservation of Lumber.

Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic.

Maryland Steel Co., Sparrows Point, Md
Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Pressure Regulators.

The Fairbanks Co., New York.
Van Auken Steam Specialty Co., Chicago, Ill.

Prospecting Drills.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulley Lathes.

Fitchburg Machine Works, Fitchburg, Mass

Pulleys, Shafting and Hangers.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works, Dayton, Ohio.

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Fishkill Landing Machine Co., Fishkill, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Walker Manufacturing Co., Cleveland, Ohio.

Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Fraser & Chalmers, Chicago, Ill.

Pumps and Pumping Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y
Colorado Iron Works, Denver, Colo.
Connersville Blower Co., Connersville, Ind.
Cook Well Co., St. Louis, Mo.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Fraser & Chalmers, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeanesville Iron Works, Jeanesville, Pa.
John H. McGowan Co., Cincinnati, Ohio.
New York Air Brake Co., 66 Broadway, N. Y.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Quarrying Machinery.

M. C. Bullock Mfg. Co., Chicago, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiator Screens.

Harrington & King Perforating Co., Chicago, Ill.

Radiators.

Crane Company, Chicago, Ill.
H. B. Smith Co., 137 Center St., N. Y.

Railroad Ditchers.

Jeffrey Mfg. Co., Cleveland, O.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Vulcan Iron Works, Toledo, Ohio.

Railroad Ties (All Kinds).

Vanderbilt & Hopkins, 123 Liberty St., N. Y.

Railway Car Brakes.

Westinghouse Air Brake Co., Pittsburg, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Railway Feed Wires.

The Conduit Co., Limited, 13 Park Row, N. Y.

Railway Freight Cars

Middletown Car Works, Middletown, Pa.

Railway Shop Machinery.

Armstrong Mfg. Co., Bridgeport, Conn.
Beaudry & Co., Boston, Mass.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Fitchburg Machine Works, Fitchburg, Mass.
J. A. Fay & Egan Co., Cincinnati, Ohio.
Ingersoll Milling Machine Co., Rockford, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Long & Allstatter Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
The Wright Co., Lowell, Mass.
Toledo Machine & Tool Co., Toledo, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Railway Specialties.

Eureka Nut Lock Co., Pittsburg, Pa.
Harrington & King Perforating Co., Chicago, Ill.
Iron City Tool Works, Ltd., Pittsburg, Pa.
Middletown Car Works, Middletown, Pa.
New York Air Brake Co., 66 Broadway, N. Y.
H. K. Porter & Co., Pittsburg, Pa.
Sheffield Car Co., Three Rivers, Mich.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railways, Portable.

C. W. Hunt Co., 45 Broadway, N. Y.

Railway Supplies.

Sheffield Car Co., Three Rivers, Mich.

Railway Track Tools.

Iron City Tool Works, Ltd., Pittsburg, Pa.

Range Boilers.

Hepe, Koven & Co., 18 Spruce St., N. Y.

Rawhide Pinions.

New Process Rawhide Co., Syracuse, N. Y

Red Lead.

Harrison Bros. & Co., Philadelphia, Pa.

Reducing Valves.

Ross Valve Co., Troy, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

Refrigerating Machinery.

Frick Company, Waynesboro, Pa.

Road-Making Machinery.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Harrisburgh F'd'y & Machine W'ks, Harrisburg, Pa.
O. S. Kelly Co., Springfield, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Road Rollers.

Addyston Pipe & Steel Co., Cincinnati Ohio.
Harrisburgh F'd'y & Machine W'ks, Harrisburg, Pa.
O. S. Kelly Co., Springfield, Ohio.

Rock Breakers.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Earle C. Bacon, 26 Cortlandt St., N. Y.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

Rock Drills.

M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Works, 26 Cortlandt St., N. Y

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Fraser & Chalmers, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 23 Park Place, N Y.
Sullivan Machinery Co., Chicago, Ill.

Rolling Mill Machinery.

Long & Allstatter Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Robert Poole & Son Co., Baltimore, Md.
Walker Manufacturing Co., Cleveland, Ohio.

Roofing.

Berlin Iron Bridge Co., East Berlin, Conn.
Canton Steel Roofing Co., Canton, Ohio.
James L. Foote, Slatington, Pa.
Gummey, McFarland & Co., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Pittsburg, Pa.
Standard Paint Co., 2 Liberty St., N. Y.
Translucent Fabric Co., Boston, Mass.
Warren Chemical and Mfg. Co., 27 Fulton St., N. Y.
Wheeling Corrugating Co , Wheeling, W. Va.

Roofs, Iron, Truss.

Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.
Maryland Steel Co , Sparrows Point, Md.
Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co , Canton, Ohio.

Rope Transmission.

Fraser & Chalmers, Chicago, Ill.
G. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Phila Pa.,

Rubber Goods.

Boston Belting Co., Boston, Mass.
Home Rubber Co., Trenton, N. J.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
N. J. Car Spring & Rubber Co., Jersey City, N. J.
Jenkins Brothers, 71 John St., N. Y.
New York Belting & Packing Co., Ltd., New York.
Spinney, Virtue & Co., Lynn, Mass.

Saw Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.

Schools.

Cheltenham Academy, Ogontz, Pa.
International Correspondence Schools, Scranton, Pa.

Screens, Mining.

Fraser & Chalmers, Chicago, Ill.
Harrington & King Perforating Co Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

Screen Plates, Punched.

Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.

Screw Machines.

Bignall & Keeler Mfg. Co., St. Louis, Mo.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Niles Tool Works, Hamilton, Ohio.

Sectional Coverings.

New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Separators, Coal and Ore.

F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.

Separators, Steam.

Goubert Mfg. Co., 14 Church St., N. Y.

Sewer Brace

Dunn Mfg. Co., Ltd., Pittsburg, Pa.

Sewer Pipe.

Charles Millar & Son, Utica, New York.
Union Sewer Pipe Co., Akron, Ohio,

Shafting.

SEE PULLEYS, ETC.

Sheet Metals.

Hepe, Koven & Co., 18 Spruce St., N. Y.

Sheet Metal Working Machinery.

Toledo Machine & Tool Co., Toledo, Ohio.

Shoes and Dies.

Chrome Steel Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.

Skylights.

Canton Steel Roofing Co., Canton, Ohio.
Translucent Fabric Co., Boston, Mass.

Slate.

James L. Foote, Slatington, Pa.

Smokestacks.

Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

Spark Guards, Perforated.

Harrington & King Perforating Co., Chicago,

Standpipes.

Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

Steam and Gas Fitters Tools.

Crane Company, Chicago, Ill.

Steam Regulating Appliances.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
The Fairbanks Co., New York.
Penberthy Injector Co., Detroit, Mich.
Jenkins Brothers, 71 John St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Co., Cleveland, Ohio.
Ross Valve Co., Troy, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

Steamships and Tow Boats.

Atlantic Works, East Boston, Mass.

Steam Shovels.

Thomas Carlin's Sons, Allegheny, Pa.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Steam Traps.

Buffalo Forge Co., Buffalo, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Van Auken Steam Specialty Co., Chicago, Ill.

Steel Ceilings.

A. Northrop & Co., Pittsburg, Pa.

Steel Importers.

Wm. Jessop & Sons, Ltd., 91 John St., N. Y.

Steel Manufacturers.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Ltd., 91 John St., N Y.
Passaic Rolling Mill Co., Paterson, N. J.

Structural Iron Work.

Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.
Maryland Steel Co., Sparrows Point, Md.

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Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Platsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Surveying Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Queen & Co., Inc , Philadelphia, Pa.

Tanks, Iron.

Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Continental Iron Works, Brooklyn, N. Y.
Fraser & Chalmers, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
S. Wilks Mfg. Co., Chicago, Ill.

Tanks, Wood.

Williams Mfg. Co., Kalamazoo, Mich.

Telegraph Wires and Cables

Eastern Electric Cable Co., Boston, Mass.
John A. Roebling's Sons Co., Trenton, N. J.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Testing Machinery.

Wm. Sellers & Co., Philadelphia, Pa.

Thermometers.

Bristol Co., Waterbury, Conn.
Queen & Co., Inc., Philadelphia, Pa.

Tin.

Gummey, McFarland & Co., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Wheeling Corrugating Co., Wheeling, W. Va.

Tin Plate Rolling Machinery.

Robert Poole & Son Co., Baltimore, Md.

Tramways.

Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.

Tramways, Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Fraser & Chalmers, Chicago, Ill,
Trenton Iron Co., Trenton, N. J.
C. W. Hunt Co., 45 Broadway N. Y.

Transmission Machinery.

Fraser & Chalmers, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill Co., Chester, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.

Tube Scrapers.

Ordway & Co., Peoria, Ill.
Sherwood Mfg. Co., Buffalo, N. Y.

Turbines.

Dayton Globe Iron Works, Dayton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
R. D. Wood, & Co., Philadelphia, Pa.

Turn Tables.

Wm. Sellers & Co., Philadelphia, Pa.

Twist Drills.

Standard Tool Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mch. Co., New Bedford, Mass.

Vacuum Pumps.

A. S. Cameron, Steam Pump Works, E. 23d St., N. Y.
Clayton Air Compressor Works, 26 Cortlandt St. N. Y.
Deane Steam Pump Co., Holyoke, Mass.

Valves, Gas, Steam, and Water.

Chapman Valve Mfg. Co., Indian Orchard, Mass
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.
Home Rubber Co., Trenton, N. J.
Jeanesville Iron Works, Jeanesville, Pa.
Jenkins Brothers, 71 John St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Ross Valve Co., Troy, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

Ventilating Appliances.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co , Chicago, Ill.
Connersville Blower Co., Connersville, Ind.
Fraser & Chalmers, Chicago, Ill.
B. F. Sturtevant Co., Boston, Mass.

Vises.

Bignall & Keeler Mfg. Co., St. Louis, Mo.

Voltmeters.

Fort Wayne Electric Corporation, Fort Wayne, Ind.
Weston Electrical Ins. Co., Newark, N. J.

Water Works Supplies.

American Well Works, Aurora, Ill.
Charles Millar & Son, Utica, New York.
Cook Well Co., St. Louis, Mo.
The Fairbanks Co., New York.
McNeal Pipe and Foundry Co., Burlington, N. J.

Water Wheels.

Dayton Globe Iron Works, Dayton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Well Sinking Machinery.

American Well Works, Aurora, Ill.
Cook Well Co., St. Louis, Mo.

White Lead.

Harrison Bros. & Co., Philadelphia, Pa.

Window Guards (Jail Work.)

Harrington & King Perforating Co., Chicago, Ill.

Wire.

Charles H. Besly & Co., Chicago, Ill.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Cloth.

Fraser & Chalmers, Chicago, Ill.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
Trenton Iron Co., Trenton, N. J.

Wood Stains,

Harrison Bros. & Co., Philadelphia, Pa.

Wood-Working Machinery.

J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.

Wrecking Cars.

Marion Steam Shovel Co., Marion, Ohio.
Middletown Car Works, Middletown, Pa.

Yachts, Steam.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.

Zinc White.

Harrison Bros & Co., Philadelphia, Pa.

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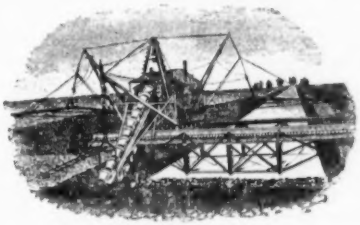
NEW YORK DREDGING CO.,

ENGINEERS AND CONTRACTORS.

Hydraulic Dredge discharging through 5,700 Ft. Pipe. Will dig and put ashore any material, Rock excepted.



Patent Canal Excavator.

Machines at work, Norfolk, Va. Galveston, Tex., and Oakland, Cal.

INCORPORATED UNDER LAWS OF NEW YORK.

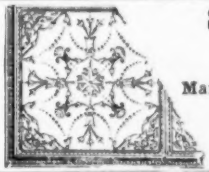
GEO. W. CATT, M. Am. Soc. C. E., President and Engineer.
O. L. WILLIAMS, Secretary and Treasurer.

SPECIALTIES:

Machinery for Economical Excavation of Canals, For Dredging, For Reclamation of Low Lands.

CORRESPONDENCE SOLICITED.

WORLD BUILDING, New York, N. Y.



STEEL CEILINGS.

ORNAMENTAL AND FIRE-PROOF.

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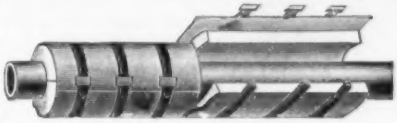

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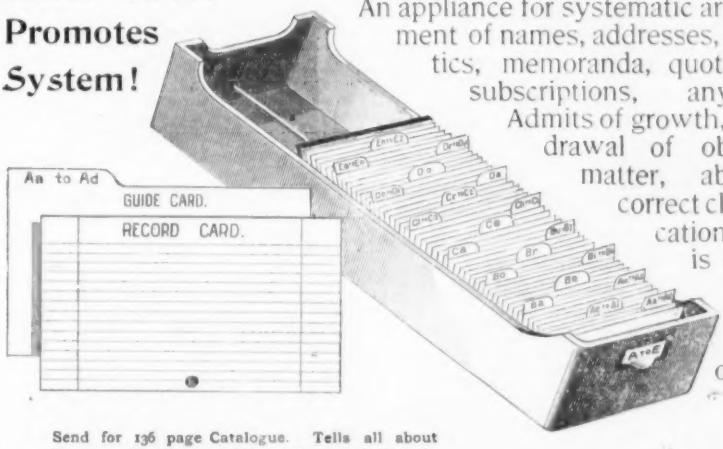

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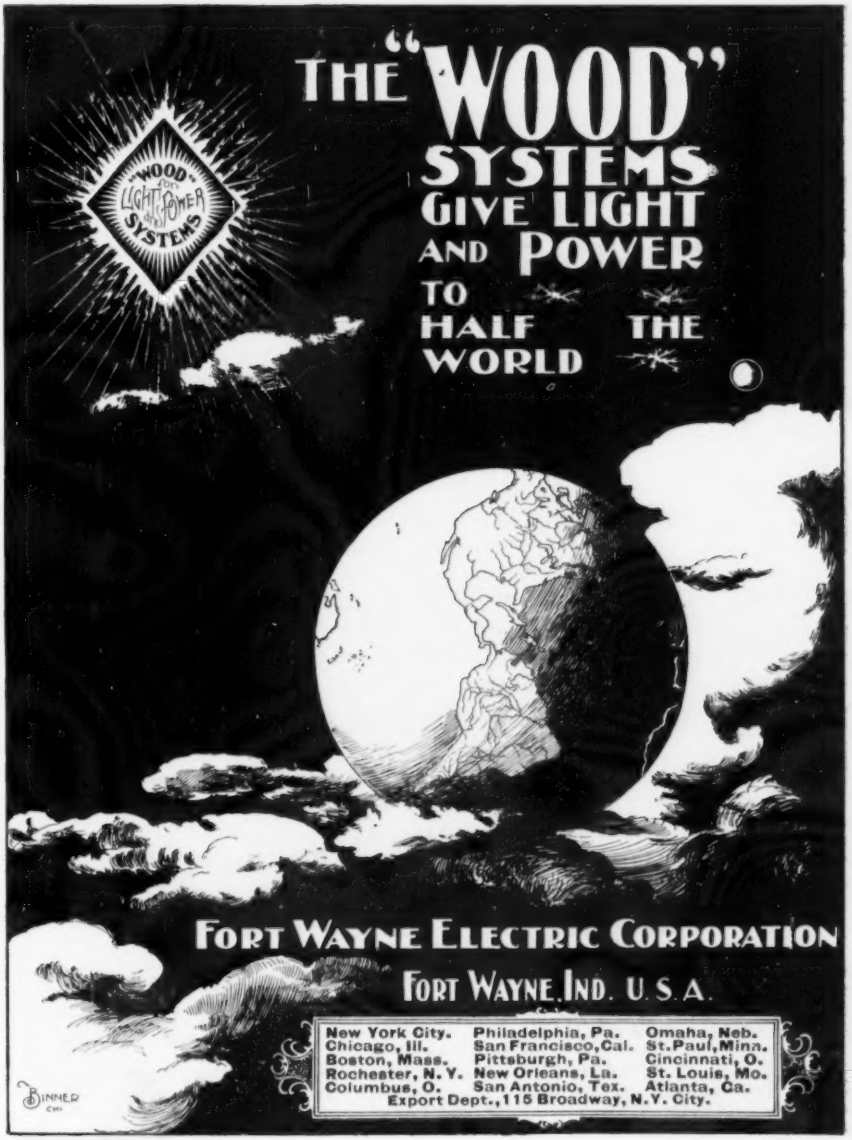
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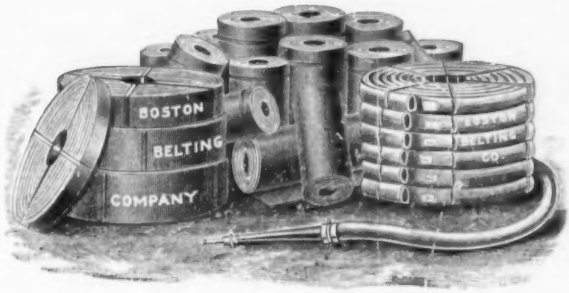

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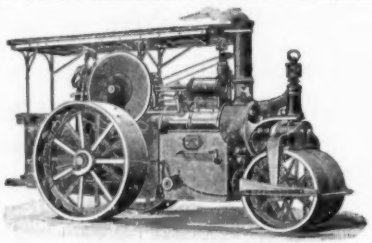

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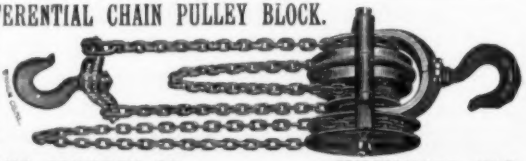

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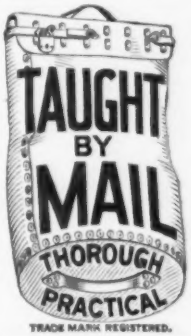

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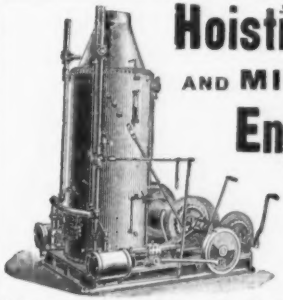

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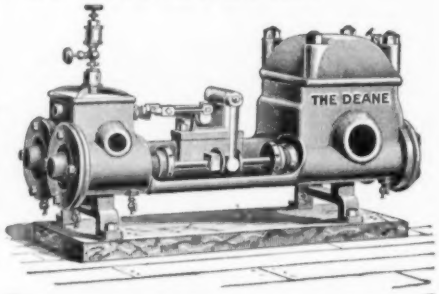

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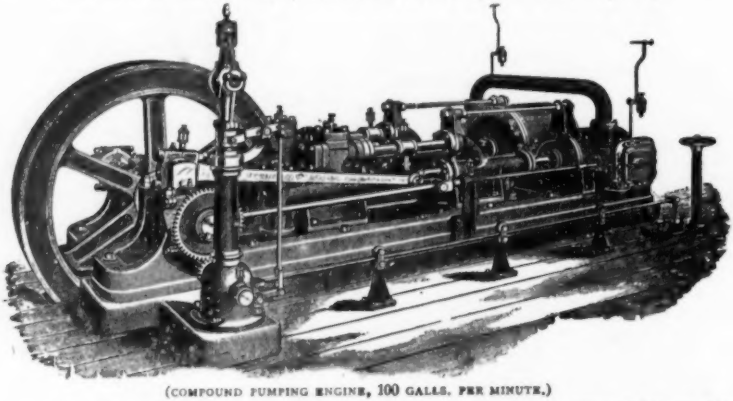

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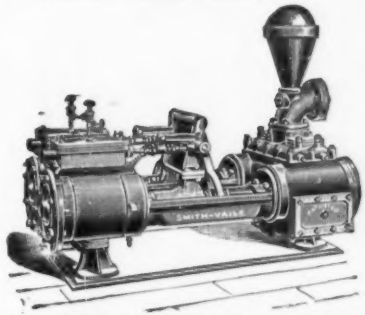

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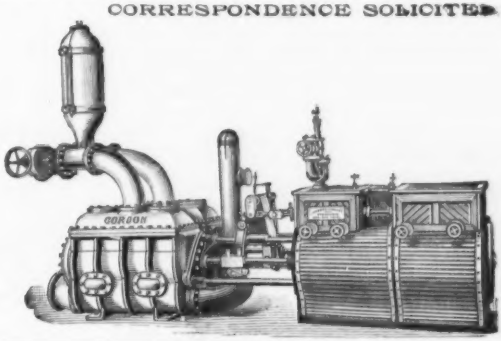

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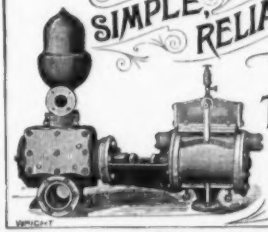

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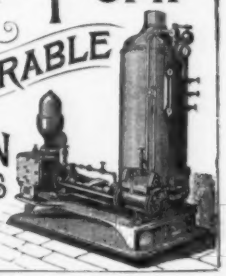

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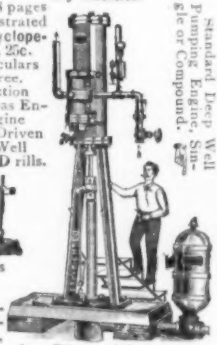

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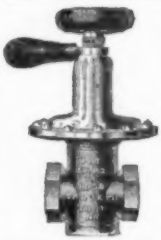

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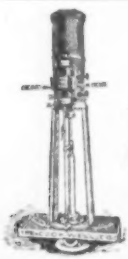

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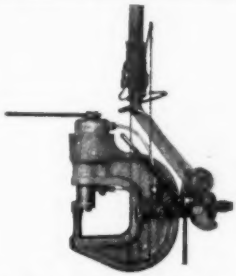

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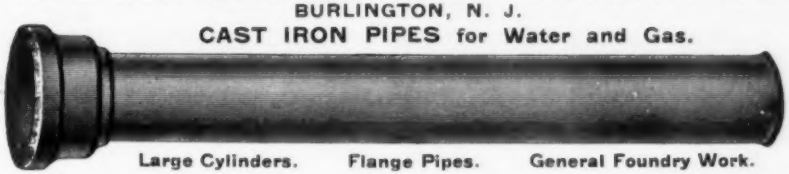

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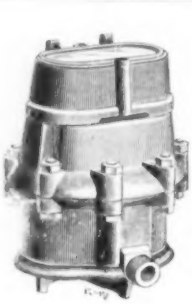

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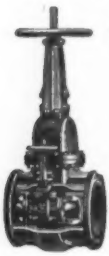

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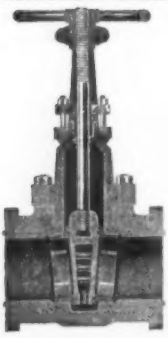

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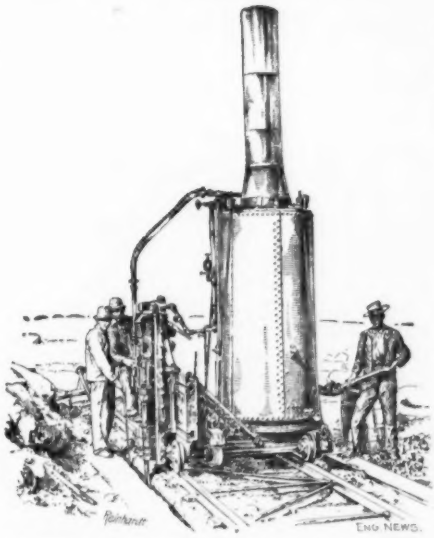

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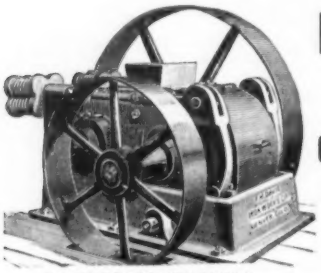

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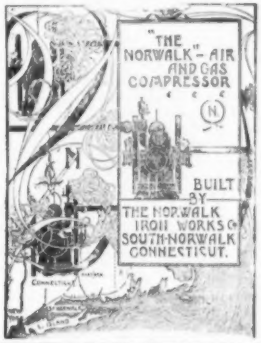

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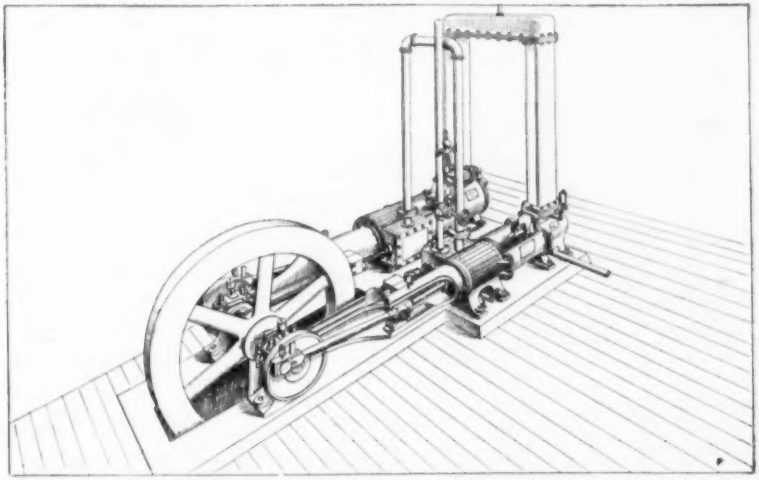

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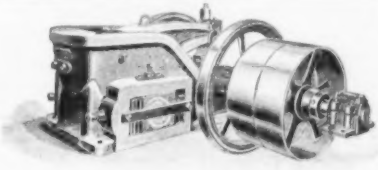

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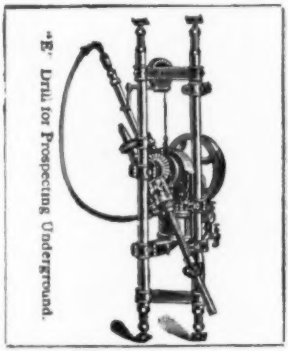

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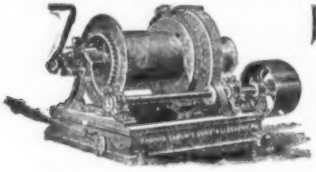

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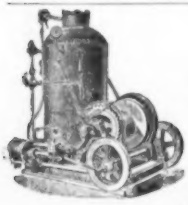

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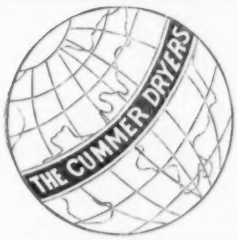

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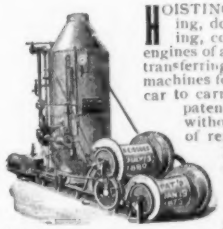

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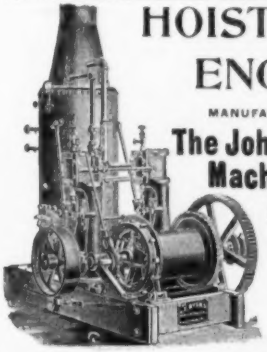

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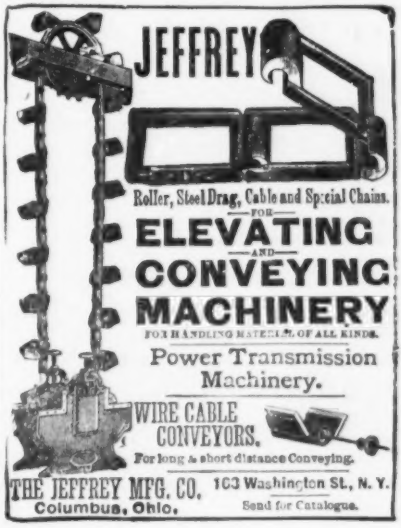

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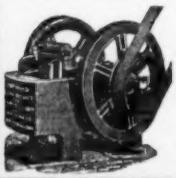

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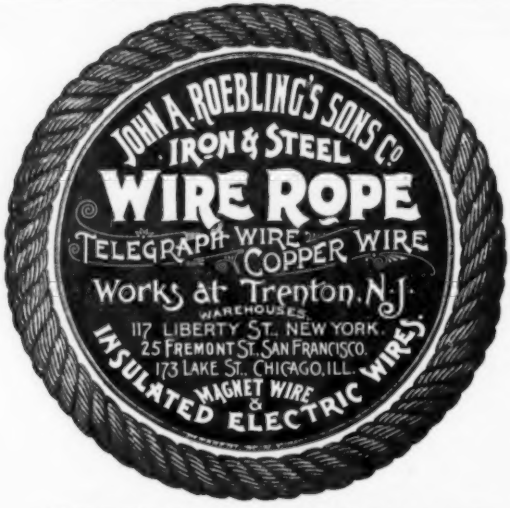

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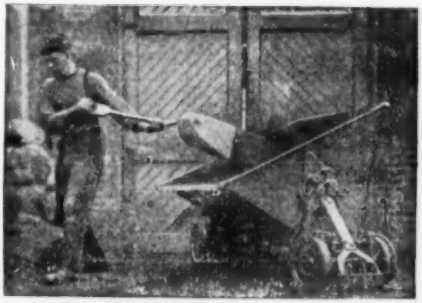

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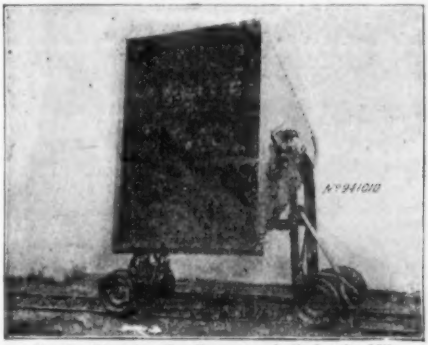

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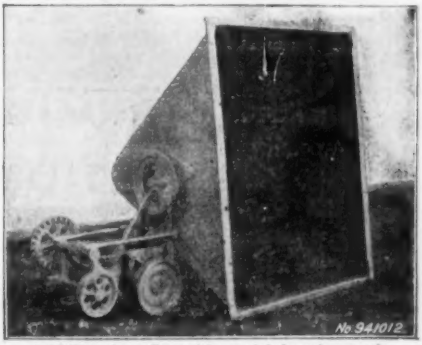

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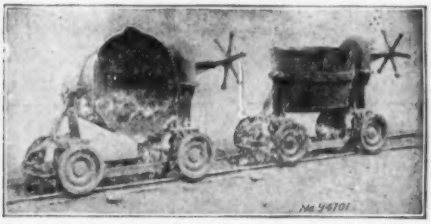

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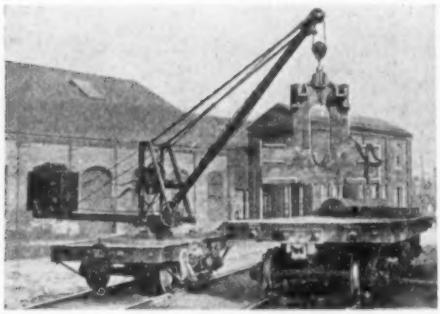

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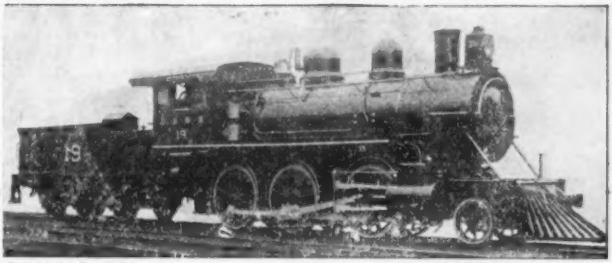

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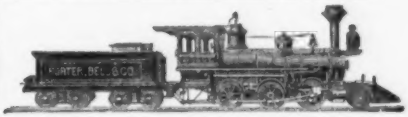

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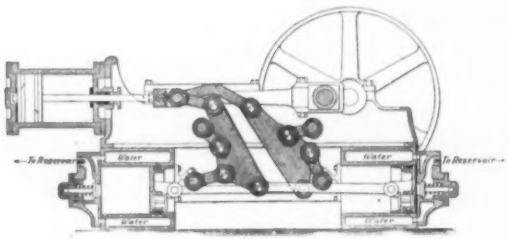

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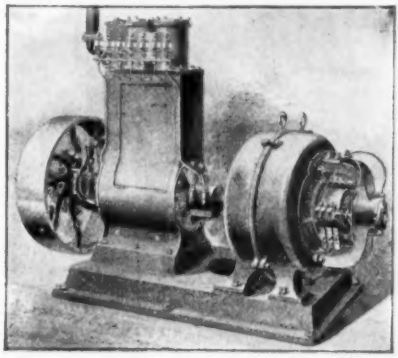

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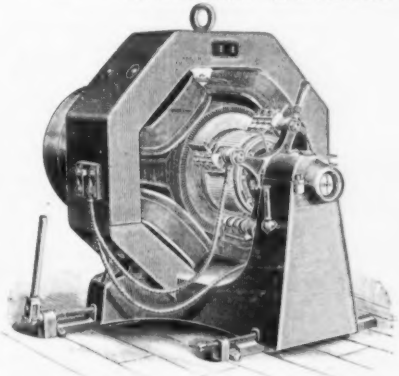

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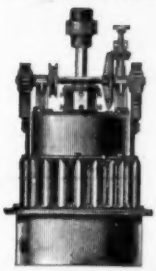

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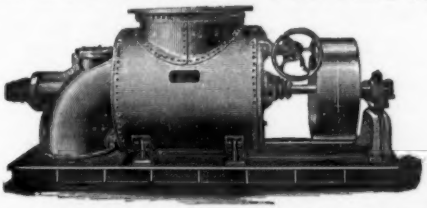

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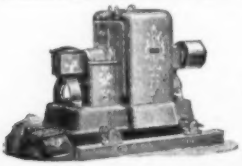

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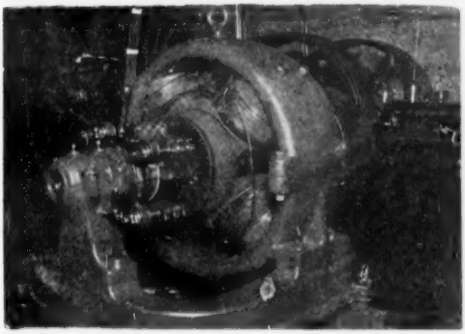

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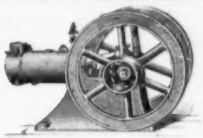

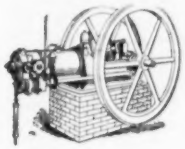

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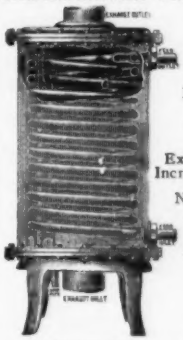

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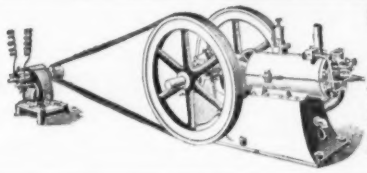

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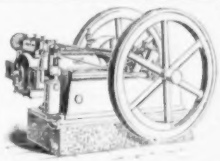

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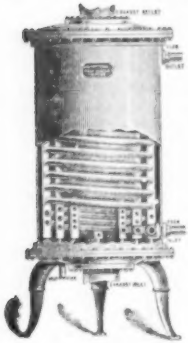

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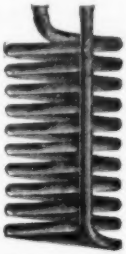

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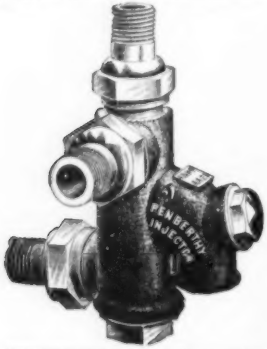

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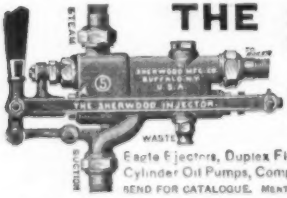

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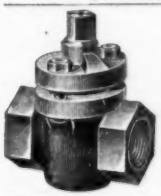

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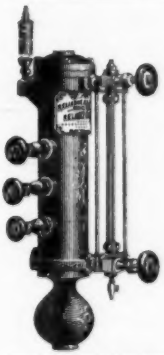

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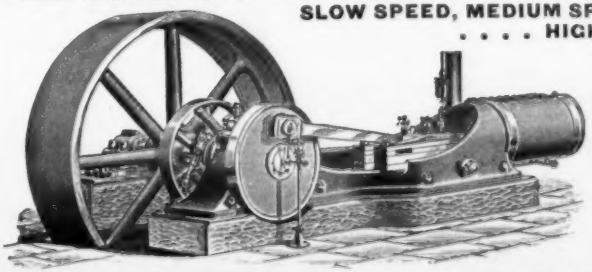

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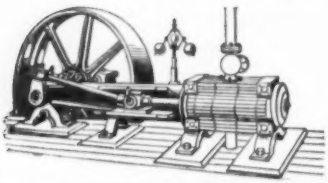

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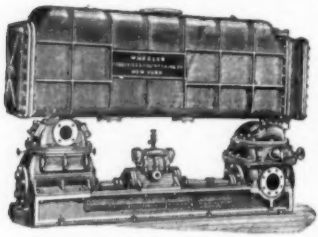

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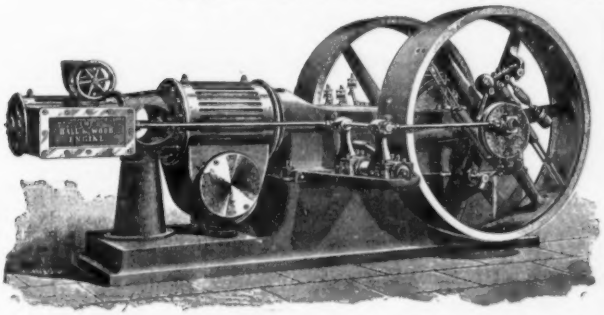

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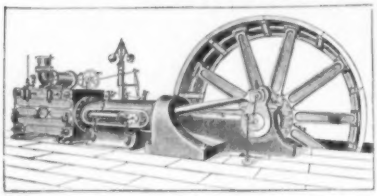

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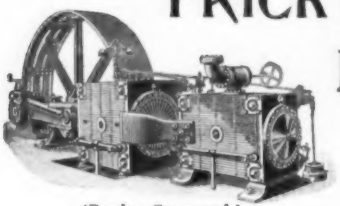

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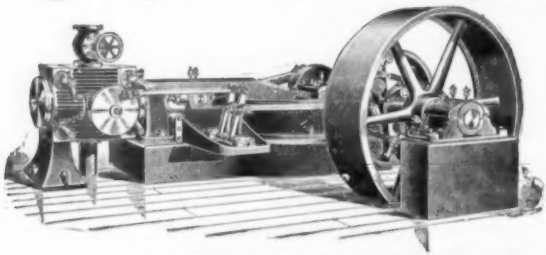

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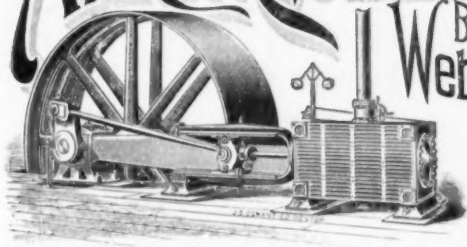

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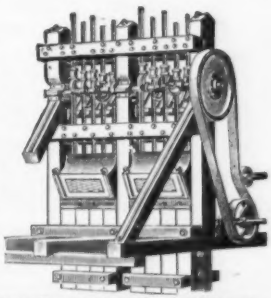

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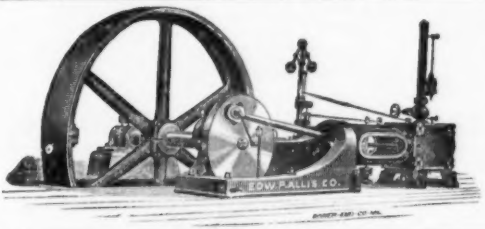

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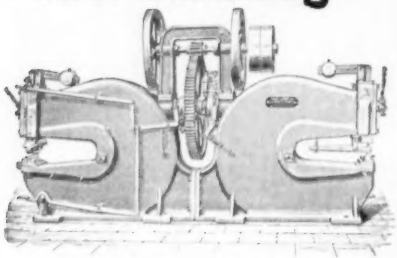

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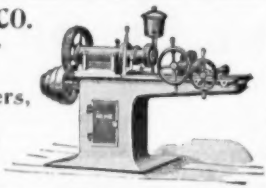

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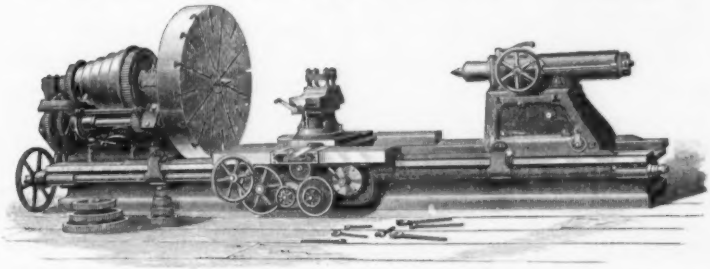

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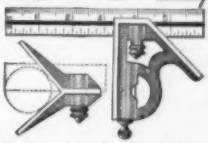

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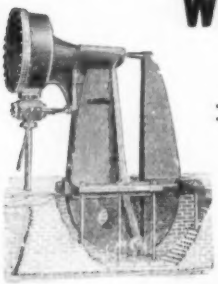

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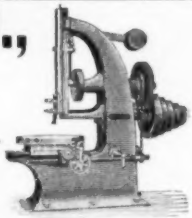

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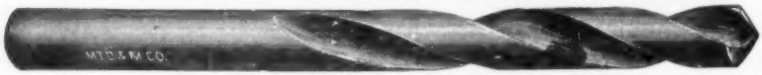

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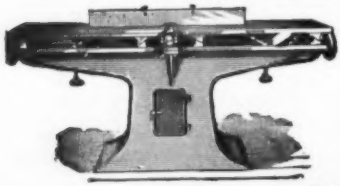

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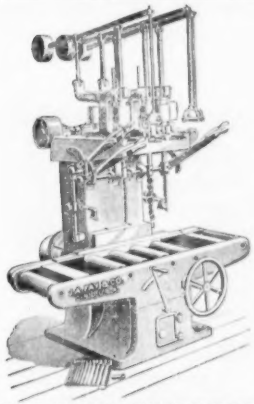

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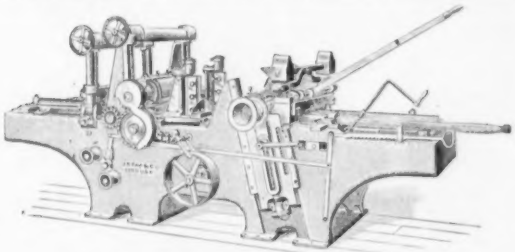

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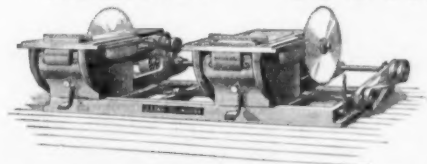

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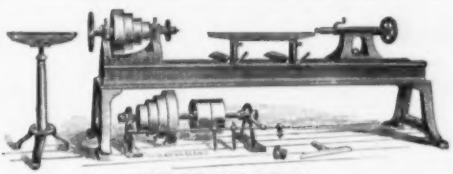

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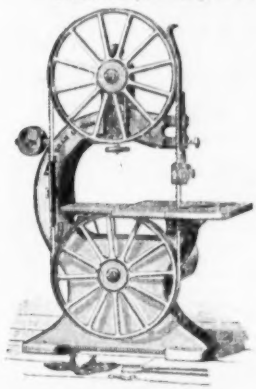

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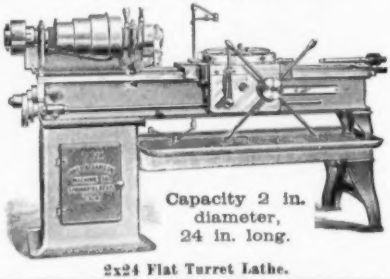

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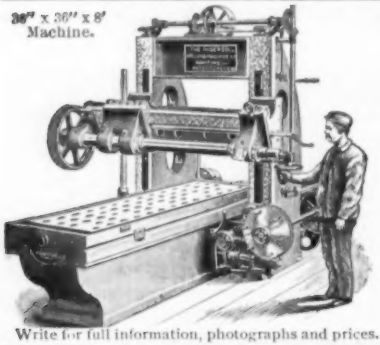

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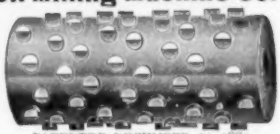

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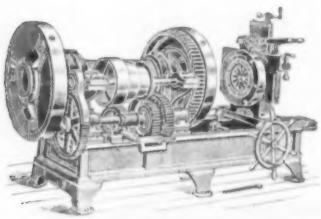

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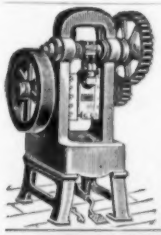

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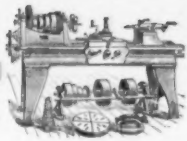

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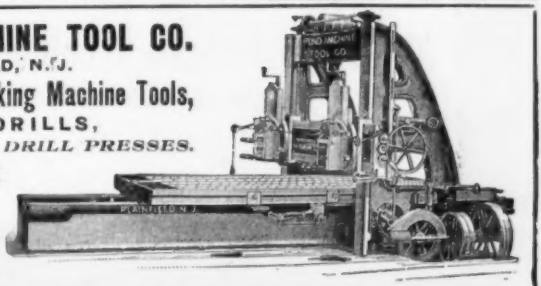

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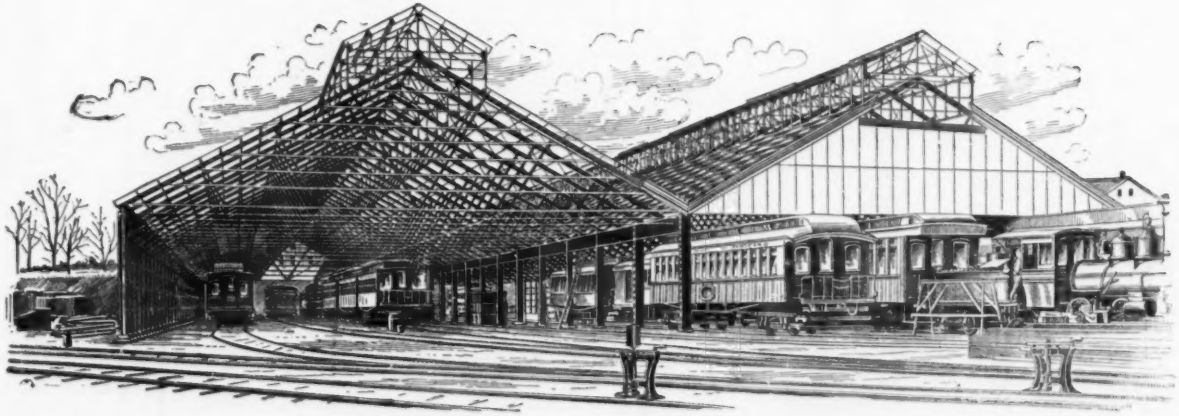

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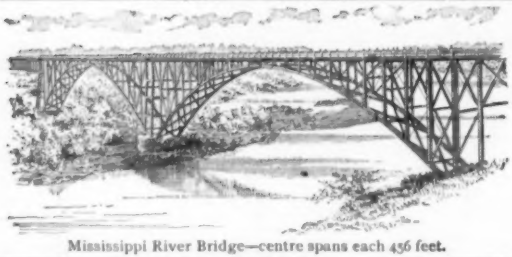

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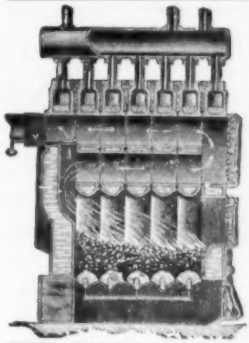

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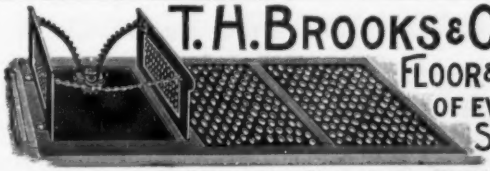

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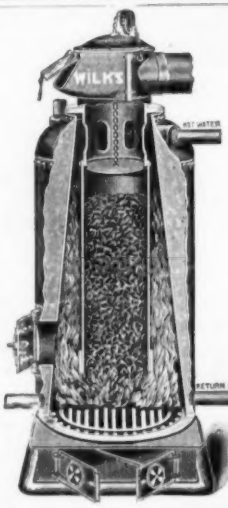

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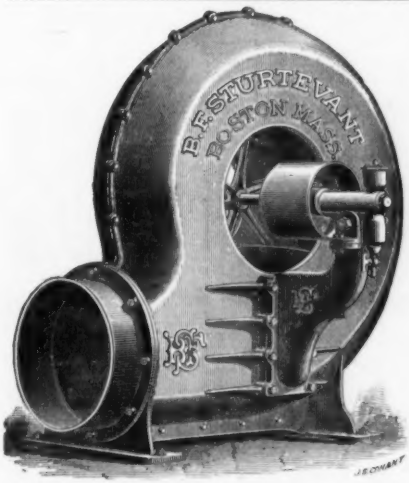

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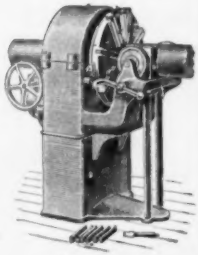

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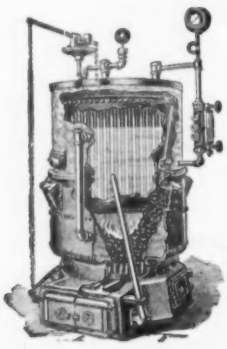

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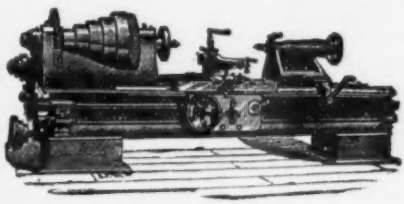

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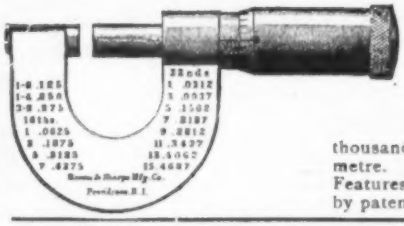

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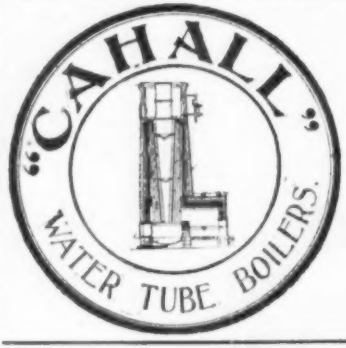

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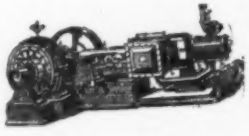

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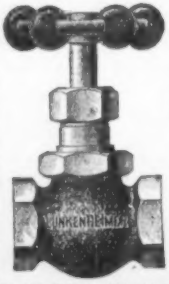

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